The Department of Defense

DEPARTMENT/AGENCIES PARTICIPATING:

Department of the Army

Department of the Navy

Department of the Air Force

Defense Advanced Research Projects Agency

Defense Nuclear Agency

Strategic Defense Initiative Organization

PROGRAM SOLICITATION 91.1

CLOSING DATE: 11 JANUARY 1991

FY 1991 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 91.1

**Small Business
Innovation
Research Program**

Issue Date: OCTOBER 1, 1990

U.S. Department of Defense

SBIR Program Office

Washington, DC 20301

Closing Date: JANUARY 11, 1991

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1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Defense Advanced Research Projects Agency (DARPA), Defense Nuclear Agency (DNA), and Strategic Defense Initiative Organization (SDIO), hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Appendix D are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense related scientific or engineering problems.

Objectives of the DoD SBIR Program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219 and PL 99-443. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, June 1988. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD. Results from prior years are shown in Reference A at the back of this solicitation.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219 and PL 99-443. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results have the potential to yield a product or process of continuing importance to DoD. Proposers are asked to consider whether the research and development they are proposing to DoD Components also has commercial possibilities, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms only on the basis of results from the Phase I effort, and *the scientific and technical merit* of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or research and development effort and is expected to produce a well defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed in part, to provide incentives for the conversion of federally sponsored research and development innovation in the private sector. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified

proposal if it is responsive to any of the topics listed in Appendix D hereto.

For Phase II, no separate solicitation will be issued as only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research development, another important goal of the program is conversion of DoD supported research or research and development into technological innovation by private firms. Therefore, on an optional basis, the DoD Program includes an incentive for proposers to obtain a contingent commitment for private follow-on funding prior to Phase II to continue the innovation process where it is felt that the research or research and development also have commercial potential.

Proposers who feel that their research or research and development have the potential to meet market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue commercial development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent on the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals are evaluated as being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in this solicitation Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer.

For both Phase I and Phase II the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act. 15 USC 631, and the definition included in this solicitation.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. Oral Communications. Oral communications with DoD Components regarding this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness, with the exceptions as stated in Section 1.6, 7.0, and Appendix D of this program solicitation.

b. Contacts for General Information of This Solicitation. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(202) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Appendix D of this solicitation.

c. Requests for Additional Copies of This Solicitation. Additional copies of this solicitation may be ordered from the Defense Technical Information Center: Attn: DTIC/SBIR, Building 5 Cameron Station, Alexandria, Virginia 22304-6415; telephone toll free (800) 368-5211 commercial for Virginia, Alaska and Hawaii (202) 274-6902.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - A systematic, intensive study directed toward greater knowledge or understanding of the subject studied.

Exploratory Development - A systematic study directed specifically toward applying new knowledge to meet a recognized need.

Advanced Development or Engineering Development - A systematic application of knowledge towards the production of useful materials, devices and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Minority and Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by one or more minority and disadvantaged individuals; or, in the case of any publicly owned business, at least 51% of the voting stock of which is owned by one or more minority and disadvantaged individuals; and

b. Whose management and daily business operations are controlled by one or more of such individuals.

While these individuals and small concerns will be required to compete for SBIR on the same basis as all other small businesses, attention will be given to a special outreach effort to ensure that minority and disadvantaged firms will have notice of this solicitation.

A minority and disadvantaged individual is defined as a member of any of the following groups; Black Americans; Hispanic Americans; Native Americans; Asian-Pacific Americans; or subcontinent-Asian Americans.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

3.0 PROPOSAL PREPARATIONS INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the technological innovation, new commercial products, process, or services which benefit the public.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation; including those contained in Appendix D.
- Use the free technical information services from DTIC (Section 7.1) and also the free assistance available at the DCAS near you (Section 7.3) and your State organization listed in Reference E.
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages.
- Don't include proprietary or classified information in the project summary (Appendix B).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise and informative research or research and development proposal of no more than 25 pages, (no type smaller than elite or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch) *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, no additional attachments, appendices or references beyond the 25 page limitation will be considered in proposal evaluation, and proposals in excess of the 25 page limitation *will not* be considered for review or award.

The proposal must address the research or research and development proposed on the specific topic chosen. It is not necessary to provide a lengthy discourse on the commercial applications in the Phase I proposal except to discuss briefly as described in Section 3.4, items b and h.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered.

a. Cover Sheet. Complete RED COPY of Appendix A, photocopy the completed form and use it as Page 1 of each copy of your proposal.

b. Project Summary. Complete RED COPY of Appendix B, photocopy the completed form and use it as Page 2 of each copy of your proposal. The technical abstract should include a brief description of the project objectives, and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, *will not* contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, by the proposing firm, consultants, or others, how it interfaces with the proposed project, and any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic. Use of DTIC is encouraged.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Briefly describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential commercial application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this Section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail, and identified in Appendix C. A minimum of <u>two-thirds</u> of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been or is funded by, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, or will be submitted or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted or will be submitted or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, please state in the proposal "No prior, current or pending support for a similar proposal."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by <u>name</u> as well as by number of <u>hours</u> dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds, will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

A Phase II proposal can be submitted only by a Phase I awardee. Phase II is not initiated by a solicitation, but a proposal must contain a Cover Sheet (Appendix A) and a Project Summary Sheet (Appendix B) of this solicitation. <u>Copies of Appendixes along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.</u>

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors, including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research, or research and development, program balance, budget limitations and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced a debriefing will be provided to unsuccessful offerors, on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government with approximately equal consideration given to each of the following criteria, except for item a., which will receive twice the weight of any other item.

a. Scientific/technical quality of the Phase I research or research and development proposal and its relevance to the topic description, with special emphasis on its innovation and originality.

b. Qualifications of the principal investigator, other key staff, and consultants, if any, and the adequacy of available or obtainable instrumentation and facilities.

c. Anticipated benefits of the research or research and development to the total DoD research and development effort.

d. Adequacy of the Phase I proposed effort to show progress toward demonstrating the feasibility of the concept.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referred to experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below. Each item will receive approximately equal weight, except for item a., which will receive twice the value of any other item:

a. Anticipated benefits of the research or development to the total DoD research and development effort.

b. Scientific/technical quality of the proposal, with special emphasis on its innovation and originality.

c. Qualifications of the principal investigator and other key personnel to carry out the proposed work.

d. Degree to which the Phase I objectives were met at the time of Phase II proposal submission.

e. Adequacy of the Phase II objectives to meet the opportunity or solve the problem.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

In the case of proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for a continued development from non-federal funding sources will be a special consideration. The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 11, 1991. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 1300 Phase I awards during Fiscal Year 1991.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects. *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on one-half person-year effort over a period generally not to exceed six months, *subject to negotiation.* The legislative history of PL 97-219 and PL 99-443 clearly envisioned a large number of Phase I awards up to $50,000 each, *adjusted for inflation.*

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate making 450 Phase II awards during Fiscal Year 1991.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, at the discretion of the government,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract.

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific and technical merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months, *subject to negotiation.* The legislative history of PL 97-219 and PL 99-443 clearly envisioned that the Phase II awards would be up to $500,000 each, *adjusted for inflation.*

5.3 Reports

SIX COPIES of a final report on the Phase I project must be submitted to the DoD Component in accordance with the negotiated delivery schedule. This will normally be within thirty days after completion of the Phase I technical effort. The final report shall include a completed SF 298, "*Report Documentation Page*" as the first page identifying the purpose of the work, a brief description of the work carried out, the findings or results, and potential applications of the effort. The summary may be published by DoD and therefore must not contain proprietary or classified information. The balance of the report should indicate in detail the project objectives, work carried out, results obtained, and estimates of technical feasibility.

To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes only to accommodate results obtained after Phase II proposal submission, and modifications required to integrate the final report into a self-contained, comprehensive and logically structured document.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 85% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendixes A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "*confidential proprietary information*" and provided that the following legend appears on the title page of the proposal:

"For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of two years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the two-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not.

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifi as a small business as defined in Paragraph 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay.)

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bonafide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original (RED COPY) plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Appendix D.

6.1 Address

Proposals (5 copies) and modifications thereof must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Appendix D to this solicitation.

One copy must be an original (RED COPY) signed by the principal investigator and an official empowered to commit the proposer. Other copies may be photocopies.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secure packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline for Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 11, 1991. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than January 4, 1991 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late received proposal sent either by registered or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages. Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference B) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number, specific topic number and be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small business may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC is the central source of scientific and technical information resulting from and describing R&D projects that are funded by DoD. DTIC searches this information for registered requesters. Reasonable quantities of paper or microfiche copies of requested documents are available for SBIR Program proposal preparation.

DTIC will also provide referrals to DoD sponsored Information Analysis Centers (IACs) where specialists in mission areas assigned to these IACs perform informational and consultative services.

Many of the small business requesters who responded to previous DoD SBIR Program solicitations believe that the scientific and technical information which DTIC provided enabled them to make better informed bid/no bid decisions and prepare technically stronger proposals. People responding to this solicitation are encouraged to contact DTIC for bibliographies of technical reports that have resulted from prior DoD funded R&D, for copies of the technical reports which are cited in these bibliographies, and for information about DoD sponsored work currently in progress in their proposal topic areas.

DTIC assistance will include references to other sources of scientific and technical information needed to prepare SBIR Program proposals to DoD. Call or visit DTIC at the following location which is most convenient to you.

All written communications with DTIC must be made to the Cameron Station, Alexandria, VA address.

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 368-5211 (toll free)
(202) 274-6902 (Commercial for Virginia, Alaska and Hawaii)

DTIC Boston On-Line Service Facility
DTIC-BOS
Building 1103, Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
AFWL/SUL Bldg. 419
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles On-Line Service Facility
Defense Contract Administration Services Region
222 N. Sepulveda Blvd.
El Segundo, CA 90245-4320
(213) 335-4170

Use Reference C at the back of this solicitation or telephone DTIC to request background bibliographies and descriptions of work in progress related to those topic areas which you plan to pursue under this solicitation. DTIC will return the material you request, annotated with a temporary User Code. This User Code is to be used by you when requesting additional information or when ordering documents cited in a bibliography until the solicitation closing date.

Because solicitation response time is limited, submit your requests for DTIC's information services as soon as possible. *To assure the fastest possible mail service, give DTIC your Federal Express Account Number to which mailing charges will be made for overnight delivery.*

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

Aerospace Research Applications Center
P.O. Box 647
Indianapolis, IN 46223
(317) 264-4644

Central Industrial Applications Center
Southeastern Oklahoma State University
Durant, OK 74701
(405) 924-6822

Information Strategists
814 Elm Street
Manchester, NH 03101
(603) 624-8208

NASA/Florida State Technology Applications Center
State University System of Florida, Progress Center
1 Progress Blvd., Box 24
Alachua, FL 32615
(904) 462-3913

NASA Industrial Applications Center
823 William Pitt Union
University of Pittsburgh
Pittsburgh, PA 15260
(412) 648-7000

NASA/UK Technology
University of Kentucky
109 Kinkead Hall
Lexington, KY 40506
(606) 257-6322

NERAC, Inc.
1 Technology Drive
Tolland, CT 06084
(203) 872-7000

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600

North Carolina Science and Technology Research Center
P.O. Box 12235
Research Triangle Park, North Carolina 27709
(919) 549-0671

Western Research Applications Center (WESRAC)
University of Southern California
3716 S. Hope Street #200
Los Angeles, California 90007
(213) 743-6132

7.3 DOD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management Regions (DCASR) activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference D at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to DCASR Activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance
- Matching funds to SBIR recipients
- Assistance in obtaining Phase III funding

Reference E contains a listing of States with established SBIR organizations known to the DOD SBIR Coordinator.

8.0 TECHNICAL TOPICS

Topics for each DoD Component are listed and numbered separately. Topics, topic descriptions, and addresses of organizations to which proposals are to be submitted are provided in Appendix D. Also included in Appendix D are instructions for completing and submitting proposals to each DoD Component.

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
   a. Identify overhead rate, the hour base and dollar cost
   b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
   a. Provide dollar cost for each item of special testing
   b. Estimated total special testing (dollars)
12. Special equipment
   a. If direct charge, specify each item and cost of each
   b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
   a. Transportation (detailed breakdown and dollars)
   b. Per diem or subsistence (details and dollars)
   c. Estimated total travel (dollars)
14. Consultants
   a. Identify each, with purpose, and dollar rates
   b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
   a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
   a. Percentage rate applied
   b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
   a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
   a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
   b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
   c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

TECHNICAL TOPICS

Each DOD component topic section contains special instructions for preparing and submitting proposals to organization within that component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

U.S. ARMY

INTRODUCTION

The Army has chosen the spring solicitation (May-July), as its primary vehicle for announcing new SBIR topics to the small business community. Consequently, this book contains only thirty topics, and we anticipate making about thirty awards next April.

We have experimented with the format of these topics by offering a few generalized topics along the lines of the Broad Agency Announcement. We continue to seek good ideas and are testing the waters of small firms with this format.

For this solicitation Phase I proposals should not exceed $50,000, so tailor your cost proposals accordingly.

Good luck and thank you for your interest in the Army SBIR Program.

J. PATRICK FORRY
Army SBIR Program Manager
(301) 394-4602

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Army Topics

Phase I proposal (5 copies) should be addressed to:

Belvoir Research, Development and Engineering Center

Topic A91-001
Commander
U.S. Army Belvoir RD&E Center
ATTN: AMSTR-PBP, SBIR Program
Bldg 314, Procurement Receptionist
Ft. Belvoir, VA 22060-5606

Hand Carry:
U.S. Army Belvoir RD&E Center
ATTN: STRBE-IL (C. Harrison)
Bldg. 312, Rm. 116
Ft. Belvoir, VA 22060-5606

Communication Electronics Command

Topics A91-002 through A91-006

Topic A91-002
CECOM Center for C3 Systems

Topic A91-003
CECOM Center for Electronic Warfare/Reconnaissance
Surveillance and Target Acquisition

Topic A91-004
CECOM Center for Software Engineering

Commander
U.S. Army Communications-Electronics Command
ATTN: AMSEL-PCCC-BID, SBIR Program
Tinton Avenue
Ft. Monmouth, NJ 07703-5000

Topic A91-005
Director
U.S. Army Center for Night Vision & Electro-Optics
ATTN: AMSEL-RD-NV-RM-FP, SBIR Program
Bldg. 305, Linda Kline
Ft. Belvoir, VA 22060-5677

Topic A91-006

Director
U.S. Army Center for Signals Warfare
ATTN: AMSEL-RD-SW-DTI, SBIR Program
Bldg. 260, Linda Monroe
Vint Hill Farms Station
Warrenton, VA 22186-5100

Chemical Research Development and Engineering Center

Topic A91-007

Commander
U.S. Army Chemical Research,
Development and Engineering Center
ATTN: AMSMC-PC-B(A)
Procurement Directorate
Bldg. 4455, SBIR Program
Edgewood Site
Aberdeen Proving Ground, MD 21010-5423

Tank-Automotive Command

Topic A91-008

Commander
U.S. Army Tank-Automotive Command
ATTN: AMSTA-IRSA
Bldg. 200A, SBIR Program
Warren, MI 48397-5000

Test and Evaluation Command

Topic A91-009

Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR, SBIR Program
Bldg. 126
White Sands Missile Range, NM 88002-5201

Laboratory Command

Topics A91-010 through A91-017

Topic A91-010

Director
U.S. Army Armament, Munitions and Chemical Command
Procurement Directorate
ATTN: AMCMC-PCM(A) SBIR Program (BRL)
Edgewood Site, Bldg. E4455
Aberdeen Proving Ground, MD 21010-5423

Topic A91-011

Commander
U.S. Army Research Office
ATTN: SLCRO-RT, SBIR Program
PO Box 12211
4300 S. Miami Blvd.
Research Triangle Park, NC 27709-2211

Topic A91-012

Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR, SBIR Program (ASL)
Building 126
White Sands Missile Range, NM 88002-5031

Topic A91-013

Director
U.S. Army Electronics Technology
and Devices Laboratory
ATTN: SLCET-DT, SBIR Program
Ft. Monmouth, NJ 07703-5000

Topic A91-014

Director
U.S. Army Materials Technology Laboratory
ATTN: SLCMT-TMT, SBIR Program
405 Arsenal Street
Bldg. 131, Rm 144
Watertown, MA 02172-2719

Topic A91-015

Commander
U.S. Army Armament, Munitions and Chemical Command
Procurement Directorate
ATTN: AMCMC-PCA(A), SBIR Program (HEL)
Edgewood Site, Bldg. E4455
Aberdeen Proving Ground, MD 21010-5423

Topic A91-016

Director
Harry Diamond Laboratories
ATTN: SLCHD-PO-RM (D. Hudson)
2800 Powder Mill Rd.
Adelphi, MD 20783-1197

Topic A91-017
Director
U.S. Army White Sands Missile Range
Vulnerability Assessment Laboratory
Directorate of Contracting
ATTN: STEWS-PR, SBIR Program
White Sands Missile Range, NM 88002-5031

Aviation Systems Command

Topic A91-018
Commander
U.S. Army Aviation Systems Command
ATTN: AMSAV-PSLZ, SBIR Program
Building 102
4300 Goodfellow Blvd.
St. Louis, MO 63120-1798

Army Institute for Research in Management Information, Communications, and Computer Science

Topic A91-019
Director
U.S. Army Institute for Research in Management
Information, Communications, and Computer Science
ATTN: ASQB-G
115 O'Keefe Bldg., Georgia Tech
Atlanta, GA 30332-0800

Army Corps of Engineers

Topic A91-020
Commander
U.S. Army Cold Regions Research and Engineering Laboratory
ATTN: CECRL-AL, SBIR Program
72 Lyme Road
Hanover, NH 03755-1290

Topic A91-021
Commander
U.S. Army Engineer Topographic Laboratories
ATTN: CEETL-PM, SBIR Program
Building 2592, Leaf Road
Ft. Belvoir, VA 22060-5546

Army Materiel Command

Topic A91-022 - A91-026

Commander
Army Materiel Command
ATTN: AMCPD-BD (L. Garcia-Baco)
5001 Eisenhower Ave.
Alexandria, VA 22333-0001

Army Medical Research Acquisition Activity

Topic A91-027 - A91-030

Commander
U.S. Army Medical Research Acquisition Activity
ATTN: SGRD-RMA-RC, SBIR Program
Ft. Detrick, Bldg. 820
Frederick, MD 21701-5014

POINTS OF CONTACT

A91-001	BRDEC	C. HARRISON	703-664-1068
A91-002 - A91-006	CECOM	J. CRISCI	201-544-2665
A91-007	CRDEC	R. HINKLE	301-671-2031
A91-008	TACOM	R. HOSTETLER	313-574-5270
A91-009	TECOM	S. MARSHALL	301-278-3906
A91-010	BRL	R. DIMMICK	301-278-6955
A91-011	ARO	W. SANDER	919-549-0641
A91-012	ASL	O. JOHNSON	505-678-3608
A91-013	ETDL	R. STERN	201-544-4666
A91-014	MTL	R. MORRISSEY	617-923-5522
A91-015	HEL	J. SISSUM	301-278-5815
A91-016	HDL	J. SATTLER	202-394-2002
A91-017	VAL	J. ARTHUR	505-678-5766
A91-018	AVSCOM	R. WARHOVER	314-263-1082
A91-019	AIRMICS	M. MIZELL	404-894-3107
A91-020	CRREL	C. MARTINSON	603-646-4244
A91-021	ETL	J. JAMIESON	703-355-2631
A91-022 - A91-026	AMC	L. GARCIA	202-274-0815
A91-027 - A91-030	MEDICAL	A. WOLF	301-663-7216

SUBJECT/WORD INDEX TO THE ARMY SBIR SOLICITATION

SUBJECT/WORD ..... TOPIC NO.

DEPARTMENT OF THE ARMY TOPICS FOR 91.1

A91-001 Combat Engineering Countermine Systems and Logistics Equipment Survivability

A91-002 Survivable Adaptive Tactical Multimedia Communications

A91-003 Target Classification in High Clutter Environment

A91-004 Reusable and Adaptive Schedulers for Ada Real-Time Applications

A91-005 Night Vision and Electro-Optics

A91-006 Tacticle Intelligence Electronic Warfare(IEW) and Data Fusion Techniques

A91-007 Chemical/Biological Defense

A91-008 Reducing The Size & Weight of Ground Combat Vehicles

A91-009 Test Range Tracking Network Processors

A91-010 Scientific Visualization

A91-011 Power Generation: Electric Power Sources and Diesel and Gas Turbine Engines

A91-012 Atmospheric Sciences

A91-013 Millimeter Wave Amplification

A91-014 Smart Materials for Army Structures

A91-015 Automatic Target Acquisition Man-Machine Interface

A91-016 Low Cost Conformal Electronically Scanned Antenna

A91-017 Electronics Warfare Vulnerability

A91-018 Army Rotocraft/Air-Vehicle Technology

A91-019 Integrated Services Digital Network Applications in the Army Environment

A91-020 Development of a Portable Ice-Thickness Measuring Instrument

A91-021 Topography, Image Intelligence and Space Exploitation

A91-022 Alternatives for Halon 1301 in Tactical Vehicle Firefighting Systems

A91-023 Environmentally Acceptable Cleaning Processes

A91-024 Environmentally Acceptable Pre-Treatment Process(es)

A91-025 Environmentally Acceptable Organic Processes and/or Coatings

A91-026 Environmentally Acceptable Inorganic Processes and/or Coatings

A91-027 Military Disease Hazards

A91-028 Combat Casualty Care

A91-029 Army System Hazards

A91-030 Medical Chemical Defense

U.S. ARMY
FY1991 TOPIC DESCRIPTIONS

BELVOIR RESEARCH DEVELOPMENT AND ENGINEERING CENTER

A91-001 TITLE: Combat Engineering Countermine Systems and Logistics Equipment Survivability

DESCRIPTION: The Belvoir RD&E Center specializes in multiplying force effectiveness, neutralizing and countering the opposition's strengths, and sustaining forces. Mine Warfare is a typical force multiplier. Mines and booby traps are readily available for purchase by hostile organizations. The ability to detect and counter such devices gives the US force a deciding edge. The existing capability is limited to the detection of metallic mines. ARMY NEEDS INCLUDE handheld and vehicular detectors which can detect both metallic and nonmetallic mines. There are no constraints on the technologies used. Proposed research should focus on the detection mechanism rather than on improved platforms, or auxiliary functions. Force effectiveness is also achieved by counter surveillance and deception. THE ARMY NEEDS Ultralight, multispectral camouflage screens, multispectral tarps and multispectral coatings. Research is required to better replicate the response of the natural environment. Battlefield deception must be affordable and a low logistics burden. IMPROVEMENTS ARE NEEDED in the design of large tactical equipment structures, and audio source synthesis and sampling techniques. Enhanced physical decoys, in both inflatable and frame/fabric versions, are required to maintain a realistic appearance to the unaided eye at distances as close as 100 yards. Improved techniques for the synthesis of battlefield sounds and the conversion of audio sources from analog to digital with a reduction in storage memory are required. Force multiplication is further achieved by increased mobility. Use of composite and other advanced materials in bridge design will result in faster crossing with less support requirements. THE ARMY NEEDS adhesive bonding and field repair techniques. Advanced materials and automated, low-labor fabrication processes are required.

Sustainment of an army is crucial to its success. The soldier always needs water, fuel and ammunition; and his modern, high tech equipment depends on electric power and air conditioning compatible with Nuclear, Biological, Chemical (NBC) conditions. Advances in automation of material handling equipment will reduce the number of people required to move ammunition and fuels at front line and rear areas. ADVANCES IN ALL THESE AREAS ARE SOUGHT which can provide substantial improvements in performance, ease of handling and reliability of the equipment.

CECOM CENTER FOR COMMAND, CONTROL & COMMUNICATION (C^3) SYSTEMS

A91-002 TITLE: Survivable Adaptive Tactical Multimedia Communications

DESCRIPTION: The objective of this effort is to develop multimedia information transport technologies for improving the survivability of distributed C3 networks. The technologies should improve the capabilities of the tactical C3 System to exchange integrated voice, data, graphics, and video in an environment consisting of multimedia, multinetted, or internetted communication resources. The technology should improve the connectivity, security, survivability, responsiveness, or capacity of future tactical communications systems including High Frequency (HF) and Very High Frequency (VHF) Combat Net Radio, Mobil Subscriber Equipment (MSE), Enhanced Position Location & Reporting System (EPLRS), Extremely High Frequency (EHF) radio, Ultra Violet (UV), and fiber optics.

High performance packet switching needs to be efficiently integrated into the Army's existing circuit switched system by utilizing a system of internetworked coaxial and fiber optic Local Area Networks (LAN). Major advances in wireless LAN technology are needed to alleviate the need for coaxial metal and fiber cabling. Maturing Integrated Services Digital Network (ISDN) technology needs to be carefully integrated into the Army's evolving C3 capability. VHF and HF Combat Net Radio (CNR) must be available to extend this battlefield internetwork to tactical units operating in dense hostile electromagnetic environments. Networks will need to exploit Artificial intelligence and Expert System technology to be adaptive to counter the threat postulated for the 21st century. They will need to respond quickly and efficiently to rapid changes in connectivity and traffic loads.

The need to exchange data will always exceed the capacity of the available communications channel. Techniques are required to exploit data compression technology for the transmission of video sensor data in packet network applications, improve the robustness of the data being sent, and to further exploit the use of wide bandwidth technologies for extended tactical local area networks. Novel Antenna and processing technologies are required to maintain wireless, survivable LAN connectivity among dispersed command post elements and mobile antonymous fighting vehicles.

CECOM CENTER FOR ELECTRONIC WARFARE/RECONNAISSANCE SURVEILLANCE AND TARGET ACQUISITION

A91-003 TITLE: Target Classification in High Clutter Environment

CATEGORY: Radar Signal Processor

OBJECTIVE: Determine what modern advances in technology can do to improve radar signal processing in the classification/identification of targets in high clutter environment.

DESCRIPTION: Current U.S. Army radar systems have a problem identifying targets in high clutter environment. This effort will identify advances in technology that will have a significant impact on how well future Army radars will identify targets in high clutter environment.

Phase I: A study will be conducted to determine the impact of recent technological advances on target identification. This study will provide an outline of how technology has grown in the following Areas: System noise reduction, increase in receivers dynamic range, low radar cross section detection, improvement in Analog to Digital (A/D) converter, filter designs, and clutter suppression. In addition, techniques use to identify targets (e.g. helicopter vs. ground vehicle, track vs. wheel) will also be outlined. Candidate classification algorithms will be described.

Phase II: Algorithms will be applied to actual radar data to assess their performance.

CECOM CENTER FOR SOFTWARE ENGINEERING

A91-004 TITLE: Reusable and Adaptive Schedulers for Ada Real-Time Applications

DESCRIPTION: Software is a major component of most tactical Army systems currently in the field or in development. The Army's mandate for the use of the Ada programming language and the desire to reap cost benefits through the reuse of software has placed additional concerns on the development of embedded real-time software systems which already have inherent performance requirements. By distributing these types of software programs to increase performance, more complexity has been added to the already difficult process of insuring that the program's tasks complete their work in their allotted time.

The Ada scheduler, contained in the runtime environment, controls and resolves task execution and intertask communication conflicts so that the real-time system can produce correct results within its time constraints. The Ada language provides a very limited ability, through the selection of eligible tasks according to priority, to explicitly control the runtime scheduling of tasks. Many scheduling algorithms now being developed require more scheduling control than that provided by the Ada tasking model. Also since scheduling algorithms are very complex or are application specific, it is unlikely that compiler vendors will be able to support very many of them in the foreseeable future in the Ada runtimes that they provide.

Therefore, application specific scheduler components, implementing particular scheduling algorithms, that could be inserted into a Ada runtime are needed. These components would provide the scheduling that is appropriate for a particular application to guarantee its timing requirements. These components would be adaptable to some degree and be interchangeable and reusable in other applications. They would also be reusable with a variety of compilers. Having them would provide a viable approach to meeting the time constraints and performance requirements of real-time systems.

This research will work toward developing a set of reusable scheduler components. It will also specify a flexible, efficient, and reusable interface to allow insertion of the components into a runtime environment and to provide the ability to adapt and reuse them. In addition, this research will seek to develop the specification of a prototype tool that could aid in the adaptation of a particular scheduler component and facilitate its incorporation into the runtime environment for a particular software application.

There are numerous emerging scheduling techniques that need to be examined, such as earliest deadline, prioritized with preemption, and priority inheritance. Variations of them and the ease of adapting them also needs to be addressed, such as modifying simple priority inheritance to full transitive priority inheritance for a particular application. There are algorithms that can support distributed processing implementations of Ada which also need to be addressed. Questions to be answered include: what is the necessary set of components that must be considered for the scheduler set? How could these components be made portable over various runtime implementations and reusable over different applications on the same runtime implementation; what are the runtime interface considerations that must be addressed? How can the performance of the components be specified so they are able to be reused with confidence in these specifications? What would be an approach to automate the incorporation of these components into an Ada runtime environment?

CECOM CENTER FOR NIGHT VISION & ELECTRO-OPTICS

A91-005 TITLE: Night Vision and Electro-optics

The CECOM Center for Night Vision and Electro-Optics (C2NVEO) mission is to provide technology, devices, sensors and sensor/processor suites to enable the Army to acquire/engage the enemy at any time of the day or night under adverse battlefield environments.

In support of this mission, the Center seeks ideas in electro-optic materials, sensors, devices, system concepts, models and architectures in the following disciplines:

a. Infrared sensors and associated devices
b. Lasers, advanced optics and adaptive optics
c. Image intensifiers both direct and remote view
d. Visionics
e. Image and signal processing

New and innovative ideas to advance the state-of-art in technologies related to infrared and Laser materials; non-linear materials; materials processing; advanced algorithms, architectures and processors for aided target recognition; models of thermal and laser target signatures and system performance models; sensor/sensor suite concepts are areas of interest to the Center.

CECOM CENTER FOR SIGNALS WARFARE

A91-006 TITLE: Tactical Intelligence Electronic Warfare(IEW) and Data Fusion Techniques

DESCRIPTION: The following three areas are of interest:

a. Communications Intercept and Location Technology Program provides improvements for the Army's tactical communications IEW capability. Topics that will be addressed over the next several years include: automated signal exploitation, on-board real-time sensor processing, extended frequency coverage, platform independent receivers and processors, high accuracy emitter location, interference cancellation and automated sensor tasking and control.

b. The Tactical Communicating Electronic Countermeasures Technology Program provides improvements for the Army's tactical communications jamming capability by reducing the effectiveness of the enemy's command and control system. topics that will be addressed over the next several years include: Electronic Warfare (EW) critical components (high power transistors, efficient antennas), new signals EW, smart jammer control, expendable jamming techniques and platform independent EW modules.

c. The Tactical Intelligence Fusion Technology Program develops new techniques, methods and approaches to critical IEW fusion problems by automating current manpower intensive correlation functions, integrating tactical intelligence data from multiple sensors, and automating IEW mission management functions. Topics that will be addressed over the next several years include: automated situation assessment. distributed processing and database management, automated terrain understanding, parallel processing and neural new technology for sensor fusion, and automated all sources processing and analysis.

CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING CENTER

A91-007 TITLE: Chemical/Biological (CB) Defense

DESCRIPTION: The proliferation of chemical warfare and increased biological capability among Third World countries necessitates that the US Armed Forces be provided with CB defense systems that are responsive to the changing threat. CB defense programs at the US Army Chemical Research, Development and Engineering Center (CRDEC) include Reconnaissance, Detection and Identification (RDI), decontamination, individual and collective protection, and flame, antimateriel and smoke/obscurant systems. Improvements in RDI will be affected by fielding new and more efficient microprocessor-based detectors with sensors utilizing spectrometry and biotechnology. Future detection systems must be capable of detecting both known and unknown CB agents. Currently under development are a hand-held mini-detector, a laser-based standoff detector and a field-hardened mass spectrometer. New decontamination systems must be able to decontaminate all CB agents from personal equipment, vehicles and sensitive equipment, i.e. electronics, with reduced logistics and operational burdens. New technologies are being sought to reduce the physiological burden of individual respiratory protective equipment. Future collective protection equipment must have lower power requirements, employ non-carbon filtration systems and be regenerable in-situ. Technologies, such as, energetic, combustible and incendiary materials and high energy oxidizers are being investigated for application to the development of combat flame systems to provide rapid

disruption and degradation of area targets. Antimateriel systems are also under development to be used to degrade/defeat threat materiel and equipment. Technologies for payload development, dissemination and fuzing, and computer modeling are being considered. The emphasis in smoke/obscuration is the development of high performance, logistically acceptable, multispectral materials which will provide usual through microwave spectral screening for large area, projectile and vehicle self-protection systems.

TANK-AUTOMOTIVE COMMAND

A91-008 TITLE: Reducing the Size & Weight of Ground Combat Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: Reduce the size and weight of future ground combat vehicles through the use of new and innovative design techniques and weight saving technologies.

DESCRIPTION: The increasing weight of the ground combat vehicle force has been primarily due to increased threat levels which have lead "conventional" designs to an overall increase in ballistic protection. This has had a direct impact on size and weight. A serious attempt to reduce the weight of the force must include lightening the structure of the vehicle allowing more weight and space claims for "dedicated" armor rather than conventional Rolled Homogeneous Armor (RHA) protection currently used in all combat vehicle hulls. Lightening the hull/structure will require new design approaches such as space frame, thick section composites, and Non-monolithic hull sections. Other design approaches would include: crew reduction and automation, Non-traditional survivability techniques/technologies and new lethality mechanisms.

The US Army TACOM Research, Development & Engineering (RDE) Center is planning the development of a High Energy Advanced Technology Transition Demonstrator (HEATTD) which will include input from Materials Technology Laboratory (MTL), Aviation Systems Command (AVSCOM), industry and universities to obtain a best technical approach for the lightest design alternative.

Phase I: The contractor(s) would identify all promising weight reduction technologies; both current and potential. This would include materials, structural design modifications, crew reduction, automation, non-traditional survivability methodology and new lethality mechanisms.

Phase II: Develop analytical assessments of all available and future technologies, and determine the best technical approach for an advanced demonstrator. Begin plans to design and develop a test bed demonstrator.

TEST AND EVALUATION COMMAND

A91-009 TITLE: Test Range Tracking Network Processors

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to develop a board(s)-level processor for real-time applications, applicable in an integrated tracking network to combine the outputs of the tracking instruments currently available at the test range. Both single and multiple target tracking scenarios must be addressed.

DESCRIPTION: The research is directed toward the development of a realtime, reconfigurable microcomputer architecture and its processor hardware. The processor application in the integrated tracking network is multi-purpose, to serve as a signal processor, data processor, merge processor, or local/global processor.

Phase I: This research effort is to accomplish the following: (1) identify the promising candidate tracking instruments for the make-up of the integrated tracking network from the currently available instruments at the test range, (2) develop preliminary design and specification for the reconfigurable microcomputer and its processor hardware suitable for an integrated tracking network and (3) identify currently available chip and board technologies and future near-term technologies applicable to (2) above.

Phase II: This research effort is the final design, fabrication and demonstration of the processor hardware based upon the reconfigurable architecture concept developed.

BALLISTIC RESEARCH LABORATORY

A91-010 TITLE: Scientific Visualization

DESCRIPTION: A new set of visualization tools needs to be developed to address the special needs of high performance computing. With the advent of the current crop of high performance workstations, three-dimensional manipulation of graphic objects has become routine. This development dovetails nicely with recent developments in mathematical modeling.

Several laboratories are actively engaged in computing three-dimensional, time-accurate, dynamic simulations of complex phenomena in continuum mechanics. Typical calculations executed on supercomputers and minicomputers involve roughly a million spatial grid points (at each time step) which map to several variables such as pressure, vorticity, stress, etc. Many of these large-scale calculations demonstrate excellent correspondence to experimental data. However, the computation itself constitutes only half the story. Analyzing the voluminous results presents a staggering challenge and the likely source of help appears to reside in the realm of graphics. Some new software tools need to be developed to effectively explore large 3D data sets (gigabyte regime). This should address data compression technology and the capabilities of graphics hardware. Advances of contouring algorithms need to be exploited to display very complex (non-convex) domain and range spaces. Surface plotting and level sets of 4D computations should be addressed. Animation will be essential to visualize time histories and stability analyses (such as bifurcation and catastrophe maps). New software tools are required in display of complicated gridding applications. This should include moving grids and depicting gridding with both 2D and 3D components. And finally, there is a strong need to study techniques of matching data from physical models with computer simulations. In particular, visualization tools need to be developed which mirror the physical techniques of dye injection, laser doppler velocimetry, and streaking. Unless one has a method of duplicating this with computed data sets, it is very tough to compare experiment with simulation.

ARMY RESEARCH OFFICE

A91-011 TITLE: POWER GENERATION: Electric Power Sources and Diesel and Gas Turbine Engines

DESCRIPTION: The Army has a need for new and improved electric power sources ranging upward in size from sources for personal equipment to systems for future vehicle electric drives and electric guns. Innovative research is needed to develop new power sources and conditioning which are compact, efficient, and can be scaled to the order of 1200 kw for tank electric drives. The new power sources must be able to meet Army needs for reliability, rapid start-up, and minimum signature. Approaches might include research on new electrochemical reactions, catalysts, membranes or fuels for electric power sources. A possible application of this research might be an improved fuel cell design providing for higher current density, higher output voltage, and efficiency and for fuel reforming to generate hydrogen from conventional fuels. New design concepts are sought for the utilization of waste heat and reaction products produced by electric power sources such as, in the case of fuel cells, recovery of potable water for troops and use of waste heat for fuel reforming.

Approaches are also sought which will lead to the prevention of soot formation in diesel and gas turbine engines. The approach should not decrease engine efficiency or power density (compared with AIPS-class engines) and should eliminate the initial formation of soot in engines fueled with DF-2 and/or JP-8. Novel engine designs, fuel management systems, and combustion control are some of the potential strategies which might be used to achieve this goal.

ATMOSPHERIC SCIENCE LABORATORY

A91-012 TITLE: Atmospheric Sciences

DESCRIPTION: Program focus in the atmospheric sciences is for the assessment of Army systems, tactics and materiel vulnerabilities and susceptibilities to adverse weather and battlefield environments. Research and application requirements involve five areas: 1) computer-based decision aids including the application of artificial intelligence techniques, 2) electromagnetic and acoustic propagation, 3) mesoscale and microscale nowcast and forecast meteorological model development, 4) battlefield visualization, weather-related decision aids are prepared using graphic displays, map overlays, tables, matrices, and other methods to assist the battlefield commander in decision making, and 5) insitu and remote atmospheric characterization techniques. The focus of the propagation program is the assessment of Army sensor and system performance at all wavelengths. For the meteorological models, the focus is on models and applications strongly coupled to the terrain and land use. These programs range from basic research to applications specific to particular Army systems. Battlefield visualization is four-dimensional presentation of the battlefield as seen by various sensors. The characterization program involves the development of new meteorological sensing technology and the engineering of this technology into tactical hardware, to provide the meteorological data in the field needed to assess system performance.

ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY

A91-013 TITLE: Millimeter Wave Amplification

DESCRIPTION: Millimeter waves are an integral part of satellite communications, electronic warfare and missile radar. Until recently, the prospects of amplifying significant levels of millimeter wave power using solid state devices have depended on IMPATT diodes. These devices operate at high junction temperatures making early burnout a significant risk element in any system application requiring millimeter wave power amplification.

The development of Field Effect Transistors (FETS), multiplier diodes, fine line geometric heterostructure growth breakthroughs in High Electron Mobility Transistor (HEMT) and Heterojunction Bipolar Transistor (HBT) technologies, make the promise of millimeter wave amplification with high efficiency and reliability a realistic possibility.

Since many present and proposed military systems are based on traveling wave tubes or IMPATT diodes, both of which have significant drawbacks involving circuit complexity, reliability and efficiency, there is a critical need to develop new highly reliable, efficient amplifiers which would employ new devices and circuit combinatorial techniques to develop millimeter wave amplifiers which would constitute a new generation of amplifiers for military systems applications. Specifically, millimeter wave unit amplifiers, combiners, matching networks, high efficiency solid state devices should be addressed with the goal of developing medium power amplifiers with high efficiency, reliability, producibility and maintainability at low cost.

MATERIALS TECHNOLOGY LABORATORY

A91-014 TITLE: Smart Materials for Army Structures

DESCRIPTION: Recently there has been intense activity in the development of "smart" or "intelligent" materials and functionally graded materials. This activity has been pursued enthusiastically in Japan and Europe. Some typical features of these so called smart materials are as follows:

- Embedded or bonded or intrinsic sensors which recognize and measure the intensity of environmental stimuli such as stress, strain, thermal, electric, magnetic, electromagnetic, chemical, biological or nuclear.
- Embedded or intrinsic actuators to respond in a prescribed or desired way to the stimulus.
- A control mechanism or selected response is available to respond to the stimulus in a predetermined way. The response occurs in a short or appropriated time and the material returns to its original state on removal of the stimulus.

Some clarifying examples of smart structures include: earthquake resistant structures wherein short loading and vibration resonances are dispersed via controlled/tuned force actuators, aircraft control flaps, use of electrorheological fluid filled structures to damp vibrations, embedded fiber optic sensors and shape memory alloy composites.

The purpose of this topic solicitation is to capitalize on such materials developments to enhance performance in applications to Army ground and aircraft vehicles, armor, large scale structures and machine components. Proposals are sought on the development of smart materials to:

- Reduce shock and vibration
- Defeat armor piercing weapons
- Enhance battle damage resistance
- In situ sensors, actuators and monitoring capability for a wide range of environmental conditions or more effective maintenance and life prediction of Army systems, components or equipment. Integrated packages containing, for example, electronics, coating, sheets and films, could lead to revolutionary developments.

HUMAN ENGINEERING LABORATORY

A91-015 TITLE: Automatic Target Acquisition Man-machine Interface

DESCRIPTION: A body of technology is evolving which provides the capability for assisting in detecting and identifying targets. These technologies involve the development of sensors and sensor suites, processors and displays. Target data is sensed then through software techniques and the machine is able to extract target characteristics which afford a probability of a target having been detected. These data must then be presented on a display medium for use by human operators. The development of these display presentations is critical to the effective utilization of target automation capabilities. There exist issues related to how much of the target probability data to present to the operator. In addition, operators need to have a high degree of confidence in the automated system in order to depend on it. There also exist issues on how to code the information so that the operator can extract it in a ready to use fashion. Display resolution, field-of-view, effectiveness of each of several sensors need to be made available in a simple manner to the operator. This effort needs to identify the critical man-machine issues and identify approaches to addressing the issues and developing software specifications for their implementation in future target acquisition, recognition systems.

HARRY DIAMOND LABORATORIES

A91-016 TITLE: Low Cost Conformal Electronically Scanned Antenna

CATEGORY: Exploratory Development

OBJECTIVE: In order to improve the flexibility and performance of future Army ground surveillance radars, electronically scanned (e-scan) antennas will be required. The antenna will be used with a relatively low power pulse doppler radar, and the concept selected must be adaptable to ground based as well as airborne platforms, be lightweight, low cost, and

potentially meet all Army environmental requirements.

DESCRIPTION: Typically, conformal patch antenna arrays have been developed for low cost, lower performance applications, while active apertures with a large number of individually controlled elements have been used in high value, higher performance applications. An innovative antenna design is required which will retain the low cost and flexibility of conformal arrays, while meeting stringent performance requirements. Preliminary design features of the radar include: > $\pm 45°$ azimuthal beam scanning with a nominal 5° beamwidth, fixed csc^2 elevation pattern with a nominal 30° beamwidth, and > 5% bandwidth. Minimization of sibelobes is a high priority. Consideration should also be given to circular or multiple polarizations, and adaptability to monopulse.

Phase I: To include a parametric analysis of the proposed design for various antenna shapes, beamwidths, and other parameters. The resulting antenna patterns will be used to iterate the design and optimize the theoretical performance of critical parameters. An estimate of the cost of the antenna in production for low and medium volume purchases will be prepared.

Phase II: Two implementations of the antenna concept will be fabricated. Electrical and mechanical interface definition will be provided prior to the start of the effort. Test data to include antenna patterns at various scan angles and frequencies will be taken. These antennas will be integrated into radar systems which will be field tested in order that the feasibility of the concept can be demonstrated.

VULNERABILITY ASSESSMENT LABORATORY

A91-017 TITLE: EW Vulnerability

The US Army has an extensive program designed to stress developed and developmental weapon/C-E systems to electronic warfare (EW) environments. The objective is to establish or determine each systems' performance limitations or vulnerability when exposed to existing and/or postulated EW threat environments. The EW environments consist of active and passive electronic countermeasures (ECM). A systems' EW vulnerability can be reduced by the incorporation of electronic counter-countermeasures (ECCM) into the system to harden it against hostile EW. Electronic support measures (ESM) are an integral part of the total EW picture. ESM are used to detect, locate and identify systems on a modern battlefield. The US Army vulnerability assessment (EWVA) program seeks technological advances in the ECM, ECCM, and ESM areas as well as innovative techniques and diagnostic tools that can be applied in the determination/assessment of system EW vulnerability.

The US Army's EWVA program requires applicable advances in the electromagnetic (EM) technology areas in the following portions of the EM spectrum: acoustic, visible, millimeter wave (MMW), radio frequency (RF), infrared (IR) and ultraviolet (UV). Multispectral systems operating in two or more of the above spectral bands are emerging on the modern battlefield. Technological advances in the development of broadband ECM,ECCM and ESM are required. Multispectral Sensor Technology needs to be developed to permit simultaneous operation across RD, MMW and IR-UV wavelengths. Unique, realistic and more efficient approaches in the establishment of the systems' EW vulnerability are required for the theoretical, laboratory and field investigations. A multispectral simulator utilizing automatic target recognition technology is required to assess multi sensor systems. The simulator must have the capability to generate scenes with backgrounds, targets and countermeasures in multispectral regions to include MMW, far IR and television wavelengths.

There are requirements to address advanced multispectral passive ECM, low observables and smart munitions ECM techniques. For ECM purposes, "tailoring" of the multispectral signatures of military targets such as missiles, aircraft, ground vehicles, artillery and high value assets should be addressed. Smart munitions ECM techniques must be as broadband as possible to minimize the cost of applying them to a wide variety of munitions currently undergoing development. Electro-optical countermeasures (EOCM) advances are required in both decoy and jammer categories. Advances are required in spectrally tailored IR and UV sources that can provide higher output radiation power levels with reduced weight, physical size and input power requirements. Advances in jammer modulation techniques (to frequencies as high a 5 KHZ) that can provide programmable waveform shapes as well as CW waveforms from unmodulated constant level outputs are required. ECCM technology advances are require for electro-optical (EO) devices. These ECCM techniques will be used to counter the ECM effects of lasers and RF against EO devices. The importance of very fast optical switches that are responsive to frequency agile lasers should be stressed. Optical switches should respond to very low level intensities. Emphasis should be on IR, television (TV), nightsights, UV systems and the human eye. EO devises must also be hardened to protect them from performance degradation and/or damage from RF sources. ECCM technology to protect multispectral sensors is required to prevent RF penetration of sensitive electronics while minimizing the effects on the transmission of desired EO signals.

There is a trend in the development of new weapon systems based on directed energy technology: high power microwave (HPM), high energy laser, particle beams, kinetic energy weapons, etc. Advances are required in EW techniques to counter their effects, sensors and fire control systems. These sensors include both active and passive systems. The sensors are expected to operate in the microwave through the UV regions of the EM spectrum. Advances in EW techniques are required to defeat these sensors to include search acquisition, track, discrimination, fire control and kill assessment. ECCM technology development for hardening against directed energy weapons (DEW) will be required. Near term ECCM

technology for protection of US systems against high energy lasers and HPM should be addressed. Far term efforts are required to develop technology for hardening against particle beams.

An important area in assessing the EW vulnerability of systems is the ability to perform accurate EW signature measurements across the EM spectrum. Advances are needed in target signature measurement technology that will not only provide comprehensive accurate data, but also minimize the time and cost in making the measurements.

AVIATION SYSTEMS COMMAND

A91-018 TITLE: Army Rotocraft/Air-vehicle Technology

DESCRIPTIONS: Future Army rotorcraft/air-vehicle systems will feature advanced capabilities in the areas of survivability, lethality, operability and supportability. Survivability will include signature controls, vulnerability reduction, and the optimum mixture of passive/active countermeasure systems. Lethality will be balanced between an advanced air-to-air/air-to-ground capability and will feature significant improvements
in platform maneuverability, agility, and speed, as well as advanced target acquisition and identification, integrated fir/flight control and advanced weapons. Operability will include extended ranges, mission times, self-deployability, and reduced manpower requirements, both operator and support. Supportability will be improved via advanced logistics, including use of knowledge based flight and maintenance data recorders for real time monitoring and diagnostic assessment of critical flight systems.
Enabling technology areas will include the following:

- Advanced lightweight structures and materials
- Advanced propulsion, transmission, rotors, thrust devices and flight controls
- Artificial Intelligence (AI) knowledge based information systems supporting man/machine integration, cognitive decision aiding
- Advanced pilotage/target acquisition sensors, weapons, command, control and communications
- Advanced modeling and simulation capability; to include Computational Fluid Dynamics (CFD) and man in the loop simulations respectively

Entirely new approaches to the system requirements contained in the above description are sought, as well as approaches that expand and improve present concepts and enabling technologies.

ARMY INSTITUTE FOR RESEARCH IN MANAGEMENT INFORMATION, COMMUNICATIONS, AND COMPUTER SCIENCE

A91-019 TITLE: ISDN Applications in the Army Environment

OBJECTIVE: To develop specific end user applications which solely depend upon the isdn technologies for the Army

CATEGORY: Advanced Development

DESCRIPTION: The Army has identified the Integrated Services Digital Network (ISDN) as part of the communications architectures for the future. Extensive field trials of ISDN have been conducted within both commercial and government sectors to demonstrate the potential benefit of such technology. Unfortunately, the limited number of user applications has prevented the full realization of such services. Therefore, the Army needs to evaluate the impact of ISDN on its daily operations, identify applications which accurately match ISDN capabilities to its end user needs, and support the development of such Army ISDN applications if such application requirements were not addressed by the industry.

Phase I: Phase I of this project would be (1) to identify high payoff application(s) that can be capitalize with the technical features of ISDN. (2) to demonstrate the usefulness of such application(s) in an ISDN laboratory environment.

Phase II: Phase II would require the transport and the demonstration of the application(s) identified in Phase I in an Army installation ISDN environment.

COLD REGIONS RESEARCH AND ENGINEERING LABORATORY

A91-020 TITLE: DEVELOPMENT OF A PORTABLE ICE-THICKNESS MEASURING INSTRUMENT

CATEGORY: Exploratory Development

OBJECTIVE: To develope to a marketable degree a portable instrumentation system which can be manually placed in contact with the surface of an ice-covered body of water and non-obtrusively measure the ice thickness.

DESCRIPTION: Current ice-thickness measuring techniques include drilling small holes through the ice and manually

measuring with a tape rule, or by using expensive radar equipment and consuming considerable time interpreting the data obtained. The goal of this work is to develop a system which can be backpacked by one person and used to measure ice thickness in several locations in a short time.

The instrument is to be capable of measuring ice thickness ranging from 2 inches to 24 inches with an accuracy of +/- 1/2 inch. The system must be usable on fresh-water ice containing entrained air bubbles, such as natural river or lake ice. Access to the interface between the ice and water is not permissible. Ice thickness should be displayed on a digital panel meter easily readable in conditions ranging from bright sunlight to darkness. The instrument should be capable of operating at temperatures down to -40I F.

Phase I: a. Determine feasibility of instrumentation to meet the above requirements.
b. Develop a working "breadboard model" which will meet the above requirements.
c. Conduct laboratory tests to verify proper performance of the "breadboard model".

Phase II: Design and fabricate a prototype of the system evaluated in Phase I. The end product will be a calibrated prototype instrument which has been demonstrated to meet the requirements above.

ENGINEERING TOPOGRAPHIC LABORATORY

A91-021 TITLE: Topography, Image Intelligence and Space Exploitation

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative and unique approaches involving parallel computer architectures for a real time, knowledge engineering based tactical decision aids system which exploits terrain, weather and other environmental factors to produce information of relevance to command decisions on the battlefield.

DESCRIPTION: Current Tactical Decision Aids (TDA) systems are slow to produce results and require substantial expertise on the part of the user to produce decision aids which provide decision relevant knowledge to the battlefield commander. Expert personnel to man these systems are extremely rare and difficult to retain in the service. Time to analyze and produce a result is a commodity in short supply in tactical situations. The system envisioned will combine "real world knowledge" derived from the field observations, remote sensor systems, and traditional terrain data sources placed into a geographic information system, with an interactive expert knowledge engine to produce interactive, near-real-time tactical decision aids which not only present to the commander specific knowledge required to make decisions but also permit interactive query to view alternatives, including estimates of the uncertainty of the result. Representative tactical decision aids are: Best location for supply facilities in a division rear: Allocation of high ground sites to sensor systems; Movement corridors for main battle units and preparation of march orders; Integrated air defense planning; Integrated defensive fires for fire support; JSTARS patrolling patterns; Smart weapons deployment planning tool, etc..

Phase I: Identify candidate approaches for development of a system to meet the stated objective, reviewing technologies applicable to its implementation and information requirements to establish expert systems, and recommend a best system.

Phase II: Procure a brass board systems (this may include equipment owned by the Engineer Topographic Laboratories and be located within the Laboratories) and develop expert shells to implement at least two of the representative TDAs indicated the objective. Demonstrate the application of the system solution in a military Command Post Exercise (CPX) or Field Training
Exercise (FTX).

Phase III: The system should be optimize and refined as a Pre-Planned Produced Improvements (P3I) for the Digital Topographic Support System and/or insertion in other tactical command and control systems.

ARMY MATERIAL COMMAND

A91-022 TITLE: Alternatives for Halon 1301 in Tactical Vehicle Firefighting Systems

CATEGORY: Advanced Development

OBJECTIVE: To produce, in a cost effective manner, alternate firefighting agent(s) that are environmentally acceptable to replace HALON 1301 for use in tactical vehicles.

DESCRIPTION: The requirement exists to develop alternate firefighting agent(s) that are environmentally acceptable to replace HALON 1301 for use in tactical vehicles. HALON 1301 is identified as a controlled substance in the Montreal Protocol and the Department of Defense Directive 6050.9, Chlorofluorocarbons/HALONS. The firefighting systems in tactical vehicles are currently designed for total flooding against explosions (extinguishing rate: 250ms to fire out) and fires for normally occupied as well as unoccupied compartments. The alternative(s) must be environmentally acceptable, non-toxic and effective against fuel, lube and oil explosions and fires. A list of agent parameters, with importance for each

application, is available upon request.

Phase I: Conduct literature and laboratory research to determine technical and scientific merits and feasibility of alternate firefighting agents that are environmentally acceptable to replace HALON 1301 for use in tactical vehicles.

Phase II: Conduct laboratory research to demonstrate and substantiate technical and scientific findings resulting from Phase I. Determine and demonstrate potential for cost effective production of identified alternate firefighting agents to replace HALON 1301.

A91-023 TITLE: Environmentally Acceptable Cleaning Processes

CATEGORY: Advanced Development

OBJECTIVE: To produce, in a cost effective manner, environmentally acceptable cleaning processes to replace Chlorofluorocarbons (CFC) 113 and other ozone depleting chemical agents used for cleaning metals and composites.

DESCRIPTION: General - The requirement exists to develop environmentally acceptable cleaning processes that comply with the Montreal Protocol and Department of Defense Directive 6050.9, Chlorofluorocarbons/HALONS. The new processes will replace current processes used to clean metals and composites. Current processes use Chlorofluorocarbons (CFC) 113 and other ozone depleting chemical agents.

Phase I: Conduct literature and laboratory research to determine technical and scientific merits, and feasibility of new cleaning processes for metals and composites that are environmentally acceptable and comply with the Montreal Protocol and Department of Defense Directive 6050.9, Chlorofluorocarbons/HALONS.

Phase II: Conduct laboratory research to demonstrate and substantiate technical and scientific findings resulting from Phase I. Determine and demonstrate potential for cost effective production of identified new cleaning processes for metals and composites.

A91-024 TITLE: Environmentally Acceptable Pre-treatment Process(es)

CATEGORY: Advanced Development

OBJECTIVE: To produce, in a cost effective manner, environmentally acceptable pre-treatment process(es) that replaces the hexavalent chromium used as a final rinse to remove unreacted phosphate salts.

DESCRIPTION: The requirement exists to develop environmentally acceptable pre-treatment processes that comply with the Montreal Protocol and Department of Defense Directive 6050.9, Chlorofluorocarbons/HALONS. The new processes will replace the current hexavalent chromium, which is not environmentally acceptable, used as a final rinse to remove unreacted phosphate salts. The waste treatment systems used to remove and dispose of the hexavalent chrome from the process waste water has become increasingly expensive. The new process(es) will exhibit the same or better corrosion resistance capabilities than hexavalent chromium.

Phase I: Conduct literature and laboratory research to determine technical and scientific merits, and feasibility of the new process(es) to replace the hexavalent chromium used as a final rinse to remove unreacted phosphate salts, and that are environmentally acceptable and comply with the Montreal Protocol and Department of Defense Directive 6050.9, Chlorofluorocarbons/HALONS.

Phase II: Conduct laboratory research to demonstrate and substantiate technical and scientific findings resulting from Phase I. Determine and demonstrate potential for cost effective production of identified new pre-treatment process(es).

A91-025 TITLE: Environmentally Acceptable Organic Processes and/or Coatings

CATEGORY: Advanced Development

OBJECTIVE: To produce, in a cost effective manner, environmentally acceptable organic processes and/or coatings.

DESCRIPTION: The requirement exists to develop environmentally acceptable organic processes and/or coatings that will eliminate the use of High Volatile Organic Compounds (VOCs), and mitigate air pollution, liquid and solid waste problems associated with High VOCs. Current processes use chemical agents that are not environmentally acceptable. The new processes will replace current organic processes and/or coatings used in the manufacturing processes involving metals and composites.

Phase I: Conduct literature and laboratory research to determine technical and scientific merits, and feasibility of new organic processes and/or coatings for metals and composites that are environmentally acceptable.

Phase II: Conduct laboratory research to demonstrate and substantiate technical and scientific findings resulting from Phase I. Determine and demonstrate potential for cost effective production of identified new organic processes and/or

coatings for metals and composites.

A91-026 TITLE: Environmentally Acceptable Inorganic Processes and/or Coatings

CATEGORY: Advanced Development

OBJECTIVE: To produce cost effective, environmentally acceptable inorganic processes and/or coatings.

DESCRIPTION: The requirement exists to develop environmentally acceptable inorganic processes and/or coatings that will eliminate the use of Cadmium and Chromium plating process, and mitigate air pollution, liquid and solid waste problems associated with these plating processes. Current processes use chemical agents that are not environmentally acceptable. The new processes will replace current inorganic processes and/or coatings used in the manufacturing processes involving metals and composites.

Phase I: Conduct literature and laboratory research to determine technical and scientific merits, and feasibility of new inorganic processes and/or coatings for metals and composites that are environmentally acceptable.

Phase II: Conduct laboratory research to demonstrate and substantiate technical and scientific findings resulting from Phase I. Determine and demonstrate potential for cost effective production of identified new inorganic processes and/or coatings for metals and composites.

MEDICAL RESEARCH ACQUISITION ACTIVITY

A91-027 TITLE: Military Disease Hazards

DESCRIPTION: Research related to either medical defense against worldwide, naturally occurring infectious diseases or medical defense against potential biological warfare agents. Current research interests are medical countermeasures against "Toxic Agents of Biological Origin," monoclonal antibodies against biological toxins, medicinal chemistry - synthesis of potential drugs effective against toxin agents of biological origin, detection, diagnosis and therapy for toxin exposure, preclinical testing of viral vaccines, and vector control systems.

A91-028 TITLE: Combat Casualty Care

DESCRIPTION: Improve the care and treatment of the injured soldier and to effect early return to duty where possible. Current research interests area high-speed parallel output solid state videocamera for maxillofacial injuries, blood and blood products, trauma injuries research, biologically compatible sustrate for cultured keratinocyte layers for burn wound coverage, and field medical, dental, and water treatment equipment and technologies.

A91-029 TITLE: Army System Hazards

DESCRIPTION: Identify and solve health problems posed by new combat materiel and new concepts for combat operations. Current research interests are high impedance neurophysiological sensors, miniaturization of angular motion sensors, environmental health monitoring equipment - sensor suite, vision and laser bioeffects, ocular protection from laser hazards, atmospheric and water related health hazards, and field sanitation methods.

A91-030 TITLE: Medical Chemical Defense

DESCRIPTION: Provide medical countermeasures to chemical warfare agents. Current research interests are vesicants or blister agents, nerve agents and neurotoxins, and blood agents.

N A V Y

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of the Chief of Naval Research. The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of the Chief of Naval Research
ATTN: Mr. Vincent D. Schaper
Navy SBIR Program Manager
800 North Quincy Street, BCT #1, Room 922
Arlington, VA 22217-5000
(202) 696-4286

The Navy has identified 290 technical topics in this DOD solicitation to which small R&D businesses may respond. A brief description of each topic is included along with the address of each originating office. In addition, there are index and topic title sections which are provided for quick reference. This information is contained on the ensuing pages.

SBIR proposals <u>shall not</u> be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's mission is to maintain the freedom of the open seas. To that end the Navy employs and maintains air, land and ocean going vehicles and personnel necessary to accomplish this mission. The topics on the following pages provide a portion of problems encountered by the Navy in order to fulfill its mission and are an increase over previous years.

Selection of proposals for funding is based upon technical merit and the evaluation criteria contained in this solicitation document. Because funding is limited the Navy reserves the right to limit the amount of topics funded under any topic and only those topics considered to be of superior quality will be funded.

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

	Administrative SBIR Contact
Topic Nos. N91-001 through N91-010	
Mail/Handcarry Address:	
Office of Naval Technology Attn: ONT Code 20T1, Room 502 SBIR Program, Topic No. N91-_____ 800 N. Quincy Street, BCT #1 Arlington, VA 22217-5000	Mr. Doug Harry (202) 696-4453
Topic Nos. N91-011 through N91-015	
Mail Address:	
Commanding Officer MCRDAC, SBIR Program, Topic No. N91-____ Amphibious Warfare Technology Directorate Quantico, VA 22134-5080	Ms. Maxine Channon (703) 640-2761
Handcarry Address:	
MCRDAC, SBIR Program, Topic No. N91-___ Amphibious Warfare Technology Directorate Lucas Hall, Room 9 Marine Corps Base Quantico, VA 22134-5080	
Topic Nos. N91-016 through N91-062	
Mail Address:	
Commander Space and Naval Warfare Systems Command Attn: SPAWAR OOK, SBIR Program, Topic No. N91-___ Washington, DC 20363-5100	Ms. Betty Geesey (703) 602-6092
Handcarry Address:	
Space and Naval Warfare Systems Command National Center #1, Room 1E58 2511 Jefferson Davis Highway Attn: SPAWAR OOK, SBIR Program, Topic No. N91-___ Arlington, VA 22202	

Topic No. N91-063	Administrative SBIR Contact

Mail Address:

Commanding Officer
Naval Medical Research & Development Command
National Navy Medical Center
Code 402 SBIR Program, Topic No. N91-
Bethesda, MD 20814-5044

Commander R. Wolf
(202) 295-1131

Handcarry Address:

Commanding Officer
Naval Medical Research & Development Command
Bldg. #1 (The Tower)
Attn: Code 402 SBIR Program, Topic No. N91-___
Bethesda, MD 20814

Topic Nos. N91-064 through N91-096

Mail Address:

Headquarters, Naval Air Systems Command
Attn: Code AIR 9342E, SBIR Program, Topic No. N91-___
Washington, DC 20361-9301

Mr. Johnny Johnson
(202) 692-7393/4

Handcarry Address:

Headquarters, Naval Air Systems Command
Jefferson Plaza #1, Room 444
1411 Jefferson Davis Highway
Attn: Code AIR-9342E, SBIR Program, Topic No. N91-___
Arlington, VA 22202

Topic Nos. N91-097 through N91-151

Mail Address:

Commander
Naval Sea Systems Command
Attn: Code CET-4, SBIR Program, Topic No. N91____
Washington, DC 20362-5101

Mr. William Degentesh
(202) 692-9871

Handcarry Address:

Commander
Naval Sea Systems Command
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Attn: Code CET-4, SBIR Program, Topic No. N91-____
Arlington, VA 22202

Topic	Administrative SBIR Contact
Topic Nos. N91-152 through N91-186	
Mail Address:	
Commander Naval Surface Warfare Center White Oak Laboratory Attn: Code R-05, SBIR Program, Topic No. N91-___ Silver Spring, MD 20903-5000	Mr. Donald Wilson (202) 394-1279
Handcarry Address:	
Commander Naval Surface Warfare Center White Oak Laboratory Bldg. #1, Reception Room Attn: Code R-05, SBIR Program, Topic No. N91-___ Silver Spring, MD 20910	
Topic Nos. N91-187 through N91-188	
Mail Address:	
Headquarters, Naval Air Systems Command Attn: Code AIR 9342E, SBIR Program, Topic No. N91-___ Washington, DC 20361-9301	Mr. Johnny Johnson (202) 692-7393/4
Handcarry Address:	
Headquarters, Naval Air Systems Command Jefferson Plaza #1, Room 444 1411 Jefferson Davis Highway Attn: Code AIR-9342E, SBIR Program, Topic No. N91-___ Arlington, VA 22202	
Topic No. N91-189	
Mail Address:	
Headquarters, Naval Air Systems Command Attn: Code AIR 9342E, SBIR Program, Topic No. N91-___ Washington, DC 20361-9301	Mr. Johnny Johnson (202) 692-7393/4
Handcarry Address:	
Headquarters, Naval Air Systems Command Jefferson Plaza #1, Room 444 1411 Jefferson Davis Highway Attn: Code AIR-9342E, SBIR Program, Topic No. N91-___ Arlington, VA 22202	

Topic Nos. N91-190 through N91-201

Administrative SBIR Contact

Mail Address:

Commander
Naval Air Development Center
Attn: Code 094, SBIR Program, Topic No. N91-___
Warminster, PA 18974-5000

Ms. Carol Van Wyk
(215) 441-2375

Handcarry Address:

Commander
Naval Air Development Center
Bldg. #3
Attn: Code 094, SBIR Program Topic No. N91-___
Warminster, PA 18974-5000

Topic Nos. N91-202 through N91-205

Mail/Handcarry Address:

Commercial Acquisition Department
Naval Underwater Systems Center
Attn: Code 0911, SBIR Program, Topic No. N91-___
Shaws Cove Office Park, Bldg. #4
Howard Street
New London, CT 06320-5594

Mr. Jack Griffin
(203) 440-4116

Topic Nos. N91-206 through N91-209

Mail Address:

Commanding Officer
Naval Air Engineering Center
Attn: Code 09R, SBIR Program, Topic No. N91-___
Lakehurst, NJ 08733-5000

Mr. Pete O'Donnel
(201) 323-7566

Handcarry Address:

Commanding Officer
Naval Air Engineering Center
Bldg. 562A
Attn: Code 09R, SBIR Program, Topic No. N91-___
Lakehurst, NJ 08733-5000

Topic No. N91-210

Mail/Handcarry Address:

Commanding Officer
Naval Civil Engineering Laboratory
Bldg. 90
Attn: Code 271, SBIR Program, Topic No. N91-___
23rd Avenue and Ventura Road
Port Hueneme, CA 93041

Ms. Mary Lingua
(805) 982-1082

Topic Nos. N91-211 through N91-215

Administrative SBIR Contact

Mail Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE34, SBIR Program, Topic No. N91-___
P.O. Box 7176
Trenton, NJ 08628-0176

Mr. Robert Dobrowolski
(609) 896-5754

Handcarry Address:

Commanding Officer
Naval Air Propulsion Center
Attn: Code PE34, SBIR Program Topic No. N91-___
1440 Parkway Avenue
Trenton, NJ 08628-0176

Topic Nos. N91-216 through N91-222

Mail Address:

Commander
Naval Air Test Center
Attn: Code CT222, SBIR Program, Topic No. N91-___
Patuxent River, MD 20670-5304

Mr. Dan Watters
(301) 863-1144

Handcarry Address:

Commander
Naval Air Test Center
Bldg. #304
Attn: Code CT222, SBIR Program Topic No. N91-___
Patuxent River, MD 20670-5304

Topic No. N91-223

Mail Address:

Commanding Officer
Naval Weapons Support Center
Attn: Code 6053, SBIR Program, Topic No. N91-___
Crane, IN 47522-5060

Mr. James Linn
(812) 854-1808

Handcarry Address:

Commanding Officer
Naval Weapons Support Center
Bldg. 2088
Attn: Code 6053, SBIR Program, Topic No. N91-___
Crane, IN 47522-5060

Topic No. N91-224

Administrative
SBIR Contact

Mail Address:

Commander
Naval Ocean Systems Center
Attn: Code 0144, SBIR Program, Topic No. N91-___
San Diego, CA 92152-5000

Dr. Richard November
(619) 553-2103

Handcarry Address:

Commander
Naval Ocean Systems Center
Attn: Code 232B, Bldg. 88, SBIR Program, No. N91-___
San Diego, CA 92152-5000

Topic Nos. N91-225 through N91-230

Mail Address:

Commander
David Taylor Research Center
Attn: Code 0112, SBIR Program, Topic No.91-___
Bethesda, MD 20084-5000

Mr. Frank Halsall
(202) 227-1094

Handcarry Address:

Commander
David Taylor Research Center
Attn: Code 0112, SBIR Program, Topic No. N91-___
Bldg. #1, Room 211
Bethesda, MD 20084-5000

Topic Nos. N91-231 through N91-234

Mail/Handcarry Address:

Commander
Naval Research Laboratory
Attn: Code 3204, SBIR Program, Topic No. N91-___
Bldg. 222, Room 115A
Washington, DC 20375-5000

Ms. Patricia Schaefer
(202) 767-6263

Topic Nos. N91-235 through N91-239

Mail/Handcarry Address:

Commander
Naval Training Systems Center
Attn: Code 641, SBIR Program, Topic No. N91-___
12350 Research Parkway
Orlando, FL 32826-3224

Mr. Robert Lynchard
(407) 380-4620

Topic / Address	Administrative SBIR Contact
Topic Nos. N91-240 through N91-279	
Mail Address:	
Commanding Officer Naval Weapons Center Attn: Code 2503, SBIR Program, Topic No. N91-___ China Lake, CA 93555-6001	Ms. Lois Herrington (619) 939-2712
Handcarry Address:	
Commanding Officer Naval Weapons Center 515 Blandy Avenue, Annex A1 Attn: Code 2503, SBIR Program, Topic No. N91-___ China Lake, CA 93555-6001	
Topic Nos. N91-280 through N91-286	
Mail Address:	
Commander Pacific Missile Test Center Attn: Code 3121, SBIR Program, Topic No. N91-___ Point Mugu, CA 93042-5000	Mr. Eugene Patno (805) 989-7916
Handcarry Address:	
Commander Pacific Missile Test Center Bldg. 50 Room 1100 Attn: Code 3121, SBIR Program, Topic No. N91-___ Point Mugu, CA 93042-5000	
Topic No. N91-287	
Mail/Handcarry Address:	
Commanding Officer Naval Avionics Center Technology Transfer Office Attn: Code 811, SBIR Program Topic No. N91-___ 6000 East 21st Street Indianapolis, IN 46219-2189	Mr. Larry Halbig (317) 353-7075

pic Nos. N91-288 through N91-290

Administrative
SBIR Contact

Ms. Karen Altieri
(301) 743-4250

Mail Address:

Commander
Naval Ordnance Station\Indian Head
Attn: Code 36B, SBIR Program Topic No. N91-___
Indian Head, MD 20903-5000

Handcarry Address:

Commander
Naval Ordnance Station Indian Head
Bldg D 340, Room 1
Attn: Code 36B, SBIR Program Topic No. N91-___
Indian Head, MD 20903-5000

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FY 1990 SMALL BUSINESS INNOVATION RESEARCH TOPICS

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N91-122 Methods of Expressing Interface Design Standards (IDS) and Protocols

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N91-124 ASW Search Planning

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N91-127 Acoustic Towed Array Motion

N91-128 Torpedo Acoustic Processing

N91-129 Active Noise Cancellation

N91-130 Acoustic Dynamic Range

N91-131 Passive Torpedo Detection/Classification Algorithm Development

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N91-133 Application of Advanced Processor Architecture to Submarine Combat Control and Acoustic Systems

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N91-135 Submarine Counter Measures Against New Technology Active Sonars

N91-136 Submarine Combat System Operator Training Workstation Concepts

N91-137 High Frequency Sonar Windows

N91-138 Expert Systems in Engagement Planning

N91-139 Sonar System Software Migration

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N91-141 Trident Command and Control Over-the-Horizon Communications

N91-142 Long Term Storage Impact on Traveling Wave Tube Life

N91-143 Microwave Filter

N91-144 Microwave Propagation

N91-145 Carbon Dioxide Reduction and/or Removal Systems

N91-146 Development of Smoke Filters

N91-147 Modeling Shipbuilding Contract Changes

N91-148 Cold Weather Logistics Over-the-Shore (LOTS) Concepts

N91-149 Optical Fiber Neutron Dosimeter

N91-150 NAVSEA Integrated LSA Process Model

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NAVAL SURFACE WARFARE CENTER

N91-152 Advanced Multiple Target Recognition Systems

N91-153 RF/IR/Dual Mode Sensor Integration/Fusion

N91-154 Application and Radiometric Characterization of Coatings

N91-155 Guidance Algorithms for High Performance Missiles

N91-156 High Power Density Actuators

N91-157 Optical Neural Networks for Automatic Target Recognition

N91-158 Integrated Photodetectors for Optical Signal Processing

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N91-160 Methodology for Predicting Fragment Induced Damage to Operating Rocket Motors

N91-161 Post-intercept Trajectories of Missile Debris Fragments

N91-162 Integrated Computing Environment for Vulnerability Modeling

N91-163 Ergonomic Replacement for Naval Console Trackball

N91-164 New High Surface Energetic Materials for Use in Slapper Devices

N91-165 Infrared Propagation Near the Sea-Air Interface

N91-166 Weapons Control Icon Development

N91-167 Coated Boron Combustion Studies

N91-168 Production of Aluminum Powder with Aluminum Fluoride Coating

N91-169 Coating of Anhydrous Lithium Perchlorate (LP)

N91-170 Technologies to Accelerate Heterogeneous Reactions Producing Energetic Material

N91-171 High Temperature Boron-Titanium Chemistry with Water

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N91-173 Militarized All-optical Non-moving Fiber Optic Switch

N91-174 Optically Driven Quartz Crystal Shutter for Use in Sensors

N91-175 Biocorrosion/Biodeterioration/Biofouling of Coated Metals

N91-176 Optical Time Domain Reflectometer (OTDR) for Network Use

N91-177 Ceramic Ferrules for Fiber Optic Connectors

N91-178 Low Halogen, Flame Resistant Cable Jacket Material

N91-179 Investigation of the Rechargeable Lithium Cobalt Oxide Cell

N91-180 Maneuvering Reentry Body Aerothermal Analysis Computer Program

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N91-183 Automated Die Bond Inspection System

N91-184 Prototype AAW Data Fusion and Command Support System (PADCS)

N91-185 Data Processing and Interpretation of ECM/ESM Contacts

N91-186 Development of High Power Microwave Technology for Microsecond Pulses

NAVAL AIR DEPOT/ NORTH ISLAND

N91-187 Superconducting Josephson Array

N91-188 Centrifugal Filtration of Corrosive Process Solutions

NAVAL AIR DEPOT/ NORFOLK

N91-189 Advanced Aircraft Wire Marking Systems

NAVAL AIR DEVELOPMENT CENTER

N91-190 Miniature Radio Frequency (RF) Decoy Thermal Battery

N91-191 Optical Neuron

N91-192 Tactical/Operator Aids

N91-193 Complex Radar Target Signature Augmentation

N91-194 Small Baseline Vector Scoring

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N91-196 Three Dimensional Radar Imaging for Scoring Applications

N91-197 Reconfigurable Infrared Detector Assembly for Dual Function Optical Scanner

N91-198 Synthetic Generation of Dynamic Infrared Scenes

N91-199 Optical Film Reader and Digital Image Processor

N91-200 Off-Board Electronic Countermeasures (ECM) for Subscale Targets

N91-201 Compliant Non-aerosol Topcoat

NAVAL UNDERWATER SYSTEMS CENTER

N91-202 Combined Combat System Models

N91-203 Shape Memory Alloy Materials Development for Actuators

N91-204 Submarine Electronic System Power Supply

N91-205 Workstation Architecture for Submarine Combat Systems

NAVAL AIR ENGINEERING CENTER

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N91-207 Feedback System for Weapons Loaders

N91-208 Automated Repairman or Autonomous Repair/Rescue Vehicles

N91-209 Advanced Materials for Wire Rope Construction

NAVAL CIVIL ENGINEERING LABORATORY

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NAVAL AIR PROPULSION CENTER

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NAVAL AIR TEST CENTER

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N91-222 Integrated Passive Targeting Equipment

NAVAL WEAPONS SUPPORT CENTER/CRANE

N91-223 Nonlinear Optical Materials

NAVAL OCEAN SYSTEMS CENTER

N91-224 Adhesives for Fiber Optic Payout Bobbins

DAVID TAYLOR RESEARCH CENTER

N91-225 Development of Shipboard Plastics Waste Processor

N91-226 Unmanned Surface Craft Demonstrator

N91-227 Development of Decentralized Actuators

N91-228 Development of Innovative Hydrophobic Membrane for Membrane Distillation Application

N91-229 Development of Gas Generators for Submarine Ballast Blowing

N91-230 Development of Magnetic Cooling Air Conditioning

NAVAL RESEARCH LABORATORY

N91-231 Millimeter Wave Chaff

N91-232 Ultra-wideband Low-loss Radio Frequency Link

N91-233 Highly Integrated Multi-band Receiver

N91-234 Broadband W-band and Higher RF Medium Power Amplifier

NAVAL TRAINING SYSTEMS CENTER

N91-235 High Definition TV Projection Via Single Crystal CRT Faceplate Technology

N91-236 Low Cost Head/Helmet Mounted Display for Simulation

N91-237 Low Cost System for Verification of the Cuing Fidelity (Motion/Visual/Instrumentation) of a Total Simulator

N91-238 Subject Matter and Pedagogical Experts for Training Device Curriculum Development and Control

N91-239 Low Cost Automatic Scenario Generator (ASG)

NAVAL WEAPONS CENTER

N91-240 Monopulse Radome Error Compensation in the Presence of Aperture Blockage

N91-241 Digital Computer Modeling of Directed Energy Weapons (DEWS)

N91-242 6-Inch Integrated Aero/Thrust Vector Control(TVC)

N91-243 Electro-rheological Fluid Damper

N91-244 Biometal Actuation

N91-245 Spherical Boron Slurry Particles

N91-246 High Energy Fuel Gel Scale-up and Production

N91-247 High Voltage Switch for Slapper Detonators

N91-248 Adaptive Contact Sensor

N91-249 Optical Fiber Guidance Payout Tension and Torque Measurement System

N91-250 Development of Prototype Multiple Aircraft Range Display System

N91-251 Coupling of Optical Fibers to Detectors in Evacuated Dewars

N91-252 Neural Network Controlled Automatic Gain Control for Low Cost IR Sensors

N91-253 Magnetically Supported Ultraprecision Bearing Development

N91-254 Active Matrix IR Scene Generation Via Polysilicon Integrated Circuit Sources

N91-255 IR Conical Scan Tracker in the Loop

N91-256 Efficient Optical Surface Finishing of Ultrahard Dome Materials

N91-257 Polishing of Poly-crystalline Diamond Films

N91-258 Anti-reflection Coatings for Use on Diamond Films

N91-259 Switchable Electrically Conductive Polymers

N91-260 Video Geometric Processor

N91-261 Multivariable Autopilot Design Using H-infinity and MU Synthesis

N91-262 Generic Guidance Integrated Fuzing Air-to-Air Missile Simulation

N91-263 IR Physical Model Generation

N91-264 IR Background Scene Generation

N91-265 Radar System Upgrade

N91-266 Image Processing of Radar Data

N91-267 Free Gyro Angle, Rate, and Phase Measurement

N91-268 Image Processing for Conical Scan IR Seekers

N91-269 Spectral Analysis of Stray Light

N91-270 RF Seeker Near Field Measurement System

N91-271 Electronic Nutation Damping of Free Gyros

N91-272 Optimized Antennas for Multispectrum Guidance

N91-273 Mpsk Synchronization Modes Study

N91-274 Qpsk and Mpsk Transmission and Receiving Equipment

N91-275 Circularly-polarized Microstrip or Stripline Antenna

N91-276 Burst Data Flywheel

N91-277 HORACE Data Channel Equipment

N91-278 Fast KUTA-class Encryptors

N91-279 Development of Fully Automated Software Testing System

PACIFIC MISSILE TEST CENTER

N91-280 Telemetry Realtime Intelligent Monitoring System (TRIMS)

N91-281 Radiation and Scattering Modeling of Microstrip Array Antennas

N91-282 Fire Free Day/Night Signal Cartridge for Practice Bombs

N91-283 Target Drone Control Via Satellite

N91-284 Global Positioning Satellite Transponder

N91-285 New Technologies for Determination of Angle of Arrival of Laser Sources

N91-286 Submarine Training Minefield Realtime Tracking System

NAVAL AVIONICS CENTER

N91-287 Multi-frequency Personal Locator Beacon/Emergency Locator Transmitter/Emergency Position Indicating Radio Beacon (PLB/ELT/EPIRB)

NAVAL ORDNANCE STATION/ INDIAN HEAD

N91-288 Degradation of Ordnance Ingredients by the White-rot Fungus Phanerochaete Chrysosporium

N91-289 Processing of Energetic Materials with Supercritical Fluids

N91-290 Removal of Combustion Gases Produced from the Thermal Treatment of Propellants from Small Rocket Motors Utilizing Gas Scrubbers

DEPARTMENT OF THE NAVY

FY 1991 TOPIC DESCRIPTIONS

OFFICE OF NAVAL TECHNOLOGY

N91-001 TITLE: Ozone Depletion Determination for Shipboard Fire Extinguishing Agents

CATEGORY: Exploratory Development

OBJECTIVE: To determine the potential ozone depletion effects of shipboard fire extinguishing agent alternatives to Halon 1301.

DESCRIPTION: Halon 1301 is a very effective fire extinguishing agent, however, because of the presence of the bromine atom, it has a high potential for destroying the earth's ozone layer. Current Navy exploratory development is identifying prospective alternatives for shipboard use. Analytical techniques and associated experimental studies on ozone depletion potential (ODP) are desired to complement the ongoing effort. Additional candidate compounds may be identified for evaluation by selected proposers.

During Phase I, a single compound will be investigated.

During Phase II, the ODP of the initial compound and that of other alternatives will be determined.

N91-002 TITLE: Millimeter-Wave Optical Waveguide Modulator

CATEGORY: Exploratory Development

OBJECTIVE: To develop optical waveguide intensity modulators operable at 1.3-1.5mm wavelength and for 3dB-bandwidth application that exceeds 20GHz.

DESCRIPTION: Using optical techniques to transfer high-speed information has many advantages over standard metallic waveguide techniques, especially in a combatant ship environment where size, weight, and EMI/EMP issues are important. For many applications, it is important to process extremely broadband information either about a center frequency or from essentially dc to a given frequency. The intensity modulator desired may operate on various principles such as (i.e., interferometric which can be fabricated on any substrate). It must be operable at an optical wavelength of 1.3 or 1.5 millimeters and be able to be efficiently coupled with single-mode optical fibers. The modulator's 3 dB bandwidth should exceed 20 GHz with a fairly flat response across the chosen frequency band.

During Phase I, an analytical model shall be used to demonstrate the feasibility of the concept.

During Phase II, a brassboard will be fabricated and demonstrated.

N91-003 TITLE: Infra-Red (IR) Signature Suppression

CATEGORY: Exploratory Development

OBJECTIVE: Identify and show feasibility of novel methods for attenuation of IR signatures in naval systems.

DESCRIPTION: Advanced Navy systems such as the Advanced Tactical Fighter (ATF) et. al., are expected to have an IR signature design requirement imposed. Novel techniques are sought to attenuate/suppress such signatures. The bidder should assume a hot spot such as an engine support structure, and propose methods for reducing the maximum temperature for a given heat flux. Passive methods of thermal control are preferred because of the possible impact of active methods on system reliability and weight. However, it is acknowledged that active methods are sometimes the only practical method for cooling. The bidder should estimate the impact of the chosen method on system weight and reliability.

Phase I: Should show the feasibility of the method.

Phase II: Should include a meaningful demonstration of IR signature suppression.

N91-004 TITLE: Solid-State Blue Laser Operating at 455 and 459 Nanometers

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the feasibility of a solid-state laser operating at the cesium atomic line filter wavelengths between 455.5 and 459.3 nanometers for use in strategic and tactical communications with submerged submarines.

DESCRIPTION: $Tm,Er{:}Y_3Sc_2Al_3O_{12}$ fluoresces at 455 and 459 nm when irradiated at 355nm, which is the third harmonic of the $Nd{:}Y_3Al_5O_{12}$ laser fundamental. The 455 and 459 nm fluorescence corresponds to the wavelengths of an existing detector system employing a cesium atomic line filter. Lasing should occur on the long wavelength side of the fluorescence.

Phase I: Construct a prototype laser using $Tm{:}Y_3Sc_2Al_3O_{12}$ with or without a sensitizer such as Er^{3+} to demonstrate feasibility (proof of principle) and determine slope efficiency.

Phase II should determine whether the laser output wavelength exactly matches the cesium atomic line filter. If not, explore the effect of an electric field or other means to bring about shifts in the wavelengths of the laser sufficient to match those of the cesium atomic line filter. Explore and evaluate various pumping schemes. Determine the optimum concentrations of Tm and sensitizer.

N91-005 TITLE: Massive Parallelism Software and Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: To develop software and algorithms for massive parallel systems.

DESCRIPTION: While a number of promising computer system architectures for massively parallel systems currently exist, a corresponding advancement in software technology and algorithms for massive parallelism has not been forthcoming. It is imperative that advances in software technology and algorithms be pursued, if we are to take advantage of this increase in compute power. Key areas of potential research and development include: fundamental principles for designing architecture independent programming languages; new compilation techniques for extracting more parallelism from programs and a mapping onto a variety of parallel architectures; methods for generating compilation and debugging systems from descriptions of machine architectures; design of retargetable implementations of efficient parallel algorithms; and software tools and environments for developing and debugging parallel systems.

Phase I: Should consist of definition and initial investigation.

Phase II: Shall expand on development of Phase 1 and implement the software routines and algorithms on a massively parallel system.

N91-006 TITLE: Detection of Buried Mines

CATEGORY: Exploratory Development

OBJECTIVE: Develop a seismic method for detecting mines buried in the ocean bottom.

DESCRIPTION: Investigation of seismic data acquisition and processing techniques is desired for the purpose of evaluating their effectiveness in detecting mines buried 3 to 4 meters below the sea floor. Current capabilities with standard sonars operating in the 30 kHz range are effective against targets buried from .3 to 1 meter depending on the degree of water saturation of the sea floor sediment. Lower frequencies (from approximately 1 to 10 kHz) are required for penetration to deeper depths.

Phase I. Predominantly theoretical in nature and include at a minimum a synthetic model of the buried mine scenario that demonstrates the effectiveness of the proposed seismic data acquisition and processing techniques. The model should incorporate the effect of sea floor elastic properties on acoustic penetration. Validation of the synthetic model with real data acquired in a laboratory or a localized field setting would be beneficial although this is not required for the Phase 1 effort.

Phase II: Conducted on a regional scale in areas prepared by the U.S. Navy and would demonstrate the effectiveness of the seismic-based technology in detecting mines buried at depths up to 4 meters.

N91-007 TITLE: High Performance Battery Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop a high-performance battery with improved energy/power density for one of the many naval requirements.

DESCRIPTION: The Navy requires high performance batteries for a wide variety of applications; to power both active surveillance systems and small vehicle propulsion systems, in particular. Future active sonobuoys being investigated for ASW

surveillance systems require a significant advance in power density over the present state-of-the art with the goal of 3.5 W/cc for the power supply, a shelf life of 5-7 years, an active life of several minutes and a total discharge time of up to 500 seconds (20 seconds pulse width, 10% duty cycle). In contrast, the AgO/Zn cells of rechargeable batteries for a naval propulsion system are limited by a relatively low cycle life, energy density and wet stand life. Although battery manufacturers report an energy density of 70 Wh/lb with 50 cycles, the swimmer delivery vehicle battery gets only 55 Wh/lb for approximately 30 cycles. Rechargeable battery capacity and cycle life could be substantially increased with improvements to either the zinc electrode, the separator, or both.

Phase I: Work will focus on battery chemistry, cathode material selection and cell design to maximize volumetric power density with small laboratory tests to demonstrate the feasibility of the chosen system or exploring novel approaches for improving the plating/cycling efficiency of the rechargeable battery zinc electrode and the stability of the separator.

Phase II: Practical cells will be constructed and tested to verify the safe delivery of high power densities, as well as the necessary active shelf-life and discharge time; or the superior rechargeable battery electrode/separator technology discovered in Phase I will be incorporated into prototype cells and tested cyclicly.

Phase III will transition for further development into the High Energy Battery Project of ONT's Mines Block (NS3B) or into one of the following NAVSEA Program Offices: Special Warfare (O6Z), Deep Submergence (PMS395) and Mobile Targets (SEA63T).

N91-008 TITLE: Wideband Sonar Signal Processor

CATEGORY: Exploratory Development

OBJECTIVE: To develop a prototype wideband monopulse processor to perform signal analysis of back-scattered signals from complex objects.

DESCRIPTION: Recent applications have been made of monopulse radar techniques in sonar design (e.g., SQQ-32). The basic method incorporates using two separate shading functions over a single aperture to obtain directional information for signals arriving at a measurement array. Theoretical work has been published on extending the basic processing scheme to wideband signals (Henderson, 1985). It is proposed that a variant of this method could be useful in analyzing backscattered returns from complex objects in order to localize the significant scattering centers in the object. The use of wideband arrays (PVDF) incorporating geometric shading is currently under investigation (Henderson) and may greatly simplify practical implementation for analysis of signals with arbitrary spectra. Specifications for wideband measurements over a decade of frequency should be incorporated in the design, the specific frequency ranges of interest will be discussed with Navy personnel.

Phase I: Work will consist of designing a multichannel measurement system to investigate the viability of applying this method to investigate the viability of applying this method to scattering center localization. Component parts would include a PVDF receive array and computer-controlled data acquisition and analysis hardware. Basic signal processing tools as well as monopulse processors would be included in the system software to provide an on-site analysis capability.

Phase II: System design will be finalized and a prototype system developed. The prototype would be tested in both a laboratory and lake environment. Data would be collected from appropriate test objects and used to evaluate performance criteria for characterizing intermediate scattering.

Phase III will develop procedures for implementing resulting analytical tools.

N91-009 TITLE: Compact High-Power Propulsion System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a compact high-power propulsion system for underwater mobile vehicles.

DESCRIPTION: This task is to design, fabricate, and demonstrate a compact propulsion system to be used in small mobile vehicles. The propulsion system required will be demonstrated in a small scale configuration. The effort will produce a propulsion system package (energy source, motor, propellers, etc.) sized not to exceed 15 inches in length by 6 inches in diameter capable of propelling 6x40 inch vehicle at 25kt for 15 minutes. The propulsion system must be controllable from one-half speed to full speed. The system should not produce excessive noise, therefore, quiet approaches are encouraged.

Phase I: Should consist of concept definition, initial investigation and detailed planning for Phase II.

Phase II: Should consist of design, fabrication, and testing of the prototype hardware concept.

N91-010 TITLE: Cleanout and Deactivation of Lithium Byproduct Canisters

CATEGORY: Exploratory Development

OBJECTIVE: Economical and safe procedures for removing byproducts of the reaction between lithium and sulfur hexafluoride from a stainless steel canister.

DESCRIPTION: Chemical energy propulsion systems now under development by the U.S Navy produce canisters filled with lithium, lithium sulfide, lithium fluoride, and trace amounts of compounds of sulfur, aluminum, potassium, and chlorine. For a given canister, these constituents and their approximate concentration can be identified a priori. They are generally insoluble in water and can be moderately reactive. Present techniques for the removal of these products involve: reacting the lithium slowly with water, then mechanical removal of the residue; mechanical removal; and melting of the contents in an inert atmosphere.

Phase I: Alternative, cost-effective, efficient approaches to remove these contents would be developed, as all the above approaches have drawbacks and limitations.

Phase II: It is required that the removal process be shown to be married with a recycling or disposal process which is environmentally acceptable and cost-effective. Actual development of these processes would be a encouraged in addition to removal.

U.S. MARINE CORPS

N91-011 TITLE: High Speed Transport of External Loads

CATEGORY: Exploratory Development

OBJECTIVE: Develop a state-of-the-art means to make external loads compatible for high speed transport (up to 200+ knots) under advanced helicopters and VTOL cargo aircraft of the future.

DESCRIPTION: Explore technology to allow high speed external transport of tactical vehicles (including the HMMWV), artillery, MILVANs, and bulk cargo. Explore the impact of high speed flight on external cargo, and modifications that might be necessary to both cargo and aircraft. Examine methods of rigging and de-rigging loads for high speed external transport, along with their associated impact on tactical flexibility and logistical concerns.

Phase I: Conduct a study outlining the approach which will be undertaken to pursue the requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: The results of this effort will include a concept (along with necessary hardware and components) developed to a state where it can be demonstrated in a flight experiment.

N91-012 TITLE: Development of Extended Red Response for a Gated, Intensified Solid State TV Camera

CATEGORY: Exploratory Development

OBJECTIVE: Extend range of current intensified gated camera systems.

DESCRIPTION: A requirement exists to have a gated (computer controllable down to a few nanoseconds) intensified solid state TV camera capable of capturing individual fields (i.e., 60 images/second) with extended red and near IR sensitivity, ideally without losing sensitivity in the blue portion of the visible spectrum. The desired response of the camera should cover a minimum spectral range of .45-1.1 microns (1.06 microns is of particular interest.).

Phase I: Should consist of a study, evaluation, and demonstration (within cost constraints) of new technologies and techniques (or extension of existing technologies) required to extend the response of such a camera into the near IR.

Phase II: Should develop and evaluate the technology/ technologies identified in Phase I for both the near IR (1.06 micron) response and the total spectral response. A gated, intensified camera with extended red response would then be fabricated and evaluated.

N91-013 TITLE: Military Personnel Assignment

CATEGORY: Exploratory Development

OBJECTIVE: Real-world problems in military personnel assignment may be predominantly linear but usually have some nonlinear aspects which are handled by piece-wise linear approximation. There is a need for metamathematical algorithms that may be piggybacked on current mathematical methods to speed convergences toward a solution and, in the case of the nonlinear regions, aid the search procedure in escape from local optima. In the event that the value of any given problem parameter is changed, the enhanced algorithm should be able to recalculate the global optimal solution in a matter of seconds (real-time).

DESCRIPTION: Generally the standard military personnel assignment problem involves the assignment of ~100 people at a time. Some-times, there is a need to match as many as 1,000 people to between 1,200 and 1,800 job vacancies. Assignments often require enroute training at a variety of training classes (~500), each with a limited student capacity. There are moving costs associated with sending any given person to any given job, largely a function of the distance travelled. Additional considerations include a fixed travel/relocation budget for the year, as well as goals for per capita moving expenses. There are constraints on personnel "balancing" in terms of fleet manning, gender, and job priority, leading to nonlinear objective functions. Additionally, if, for any reason, a person represented in the computer program should exercise his/her right to reject the job assignment and choose another, the enhanced algorithm should be able to recalculate the global optimal solution of using a new job assignment in a matter of seconds (real-time).

Phase I: Should demonstrate feasibility of method selected/devised on fully constrained, small-scale problem.

Phase II: Should demonstrate the optimum solution and measurement of computing time on fully constrained, large-scale problem(s).

N91-014 TITLE: Large Area Fast Spectroradiometer

CATEGORY: Engineering Development

OBJECTIVE: Provide high resolution, large area coverage of a scene in fine spectral increments over a large spectral range in near real time.

DESCRIPTION: Multispectral scene analysis (in field) is of great concern to the Navy and the Marine Corps. Current approaches sacrifice resolution in either the area or spectral range. Current programs whose goal is to detect targets in a large cluttered environment could profit from this proposal. Innovative concepts are sought to extrapolate current field portable, fast spectroradiometers to provide 2.5-5nm spectral resolution over a 200x300 ft coverage area at standoff distances of 1000-2000 ft and spatial resolution of <6". Lens attachments should allow for other closeup scenarios. The unit should be completely field portable and self contained and should provide for data storage. Each data storage take should be accomplished in near real time (i.e., <0.25 sec) and should function in various daytime conditions.

Phase I would consist of a study to show feasibility of producing or extrapolating from current technologies the specific device which can meet the proposal requirements.

Phase II would consist of building and delivery of a field portable unit which meets all necessary specs.

N91-015 TITLE: Fuel Adaptation

CATEGORY: Exploratory Development

OBJECTIVE: To develop a 35 hp and a 70 hp outboard motor JP-5 fuel adaptation suitable for use on USMC small craft.

DESCRIPTION: Safety constraints for gasoline handling aboard U.S. Navy amphibious shipping severely inhibit employment of USMC small craft. Development effort will adapt the OMC outboard engine to accept JP-5 aircraft fuel (standard available fuel aboard U.S. Navy amphibious shipping). Desired engine modification should be simple to apply and able to be performed at the organizational level. Modification should not significantly increase the overall weight of the engines. Target weights are less than 125 pounds for the 35 hp motor and 275 lbs for the 70 hp motor. Horsepower will be measured at the propeller. Cubic dimensions and audio signature will not differ markedly from current industry standard for gasoline-powered outboard motors. Engines will have work-boat gear ratio and long shaft design as defined by industry standard.

Phase I: Development of a prototype 35 hp and a prototype 70 hp JP-5 jet fuel modified outboard motor.

Phase II: Refinement of the design and the delivery of test articles and results of laboratory tests designed to measure performance specifications.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N91-016 TITLE: Data Compression of Geophysical Data

CATEGORY: Advanced Development

OBJECTIVE: Facilitate implementation of decentralized environmental support architecture by increasing the throughput of geophysical information through available communication channels.

DESCRIPTION: The Navy's current architecture for environmental support creates large volumes of data which are now stored and maintained on large central site mainframe computers. The next generation of environmental support systems will distribute this data for processing at shore sites and ships. The volumes of data that must be transferred exceeds the existing pipelines for data distribution available to users of geophysical information. Data compression techniques must be employed to allow the required data to flow through the available communications channels and to reduce the burden on the small scale computers that are used on ships and shore sites.

Phase I: Investigate innovative data compression concepts that have the best potential for application to geophysical data in terms of minimum information loss and maximum compression performance. Types of data to be studied include satellite imagery, graphics and multi-dimensional array fields.

Phase II: Development of data compression technique.

N91-017 TITLE: Mission Area Subnets

CATEGORY: Exploratory Development

OBJECTIVE: Provide a means to subdivide Naval Tactical Data System (NTDS) tactical data into Mission Area Subnets for improving throughput and response time to high priority track data.

DESCRIPTION: Techniques and algorithms are sought for separating NTDS track data into Mission Area Subnets (MAS) such that each MAS can be assigned a different priority, speed of delivery, and destinations. A MAS address would typically be a subset of the entire battle group (i.e., multicast versus broadcast). Network resource sharing protocols should be defined which complement MAS. Networks will include relay nodes to extend the horizon. The resulting algorithms should be developed and tested in the Naval Ocean Systems Center (NOSC, San Diego, CA) Communications Support System (CSS) test facility.

Phase I: Address the technical feasibility of the proposed effort.

Phase II: Product development.

N91-018 TITLE: Network Initialization and Synchronization

CATEGORY: Exploratory Development

OBJECTIVE: Provide for initial frequency selection and slot synchronization in a High Frequency (HF) Time Division Multiple Access (TDMA) battle group network.

DESCRIPTION: This task is to develop algorithms for initial frequency selection and slot synchronization in a HF TDMA network. Techniques need to be developed which select a HF frequency which maximizes network connectivity. This frequency selection needs to be disseminated throughout the network to each platform. Also, in the TDMA network each platform will be assigned a fixed number of TDMA slots in a fixed frame format. Upon network initialization, all platforms need to gain synchronization at both the slot and frame boundary without the use of global clocks. (It can be assumed that each platform has very stable clocks.)

Phase I: Show technical/scientific feasibility of algorithms.

Phase II: Algorithm development.

N91-019 TITLE: Internetwork Routing

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques to use mixed Radio Frequency (RF) media for distributing tactical data within a Navy battle group.

DESCRIPTION: Develop techniques and algorithms for dynamically selecting internetwork gateways. Potential gateways are ships and aircraft which have multiple RF networks. The concept is that a platform with one RF medium (such as UHF-LOS) needs to broadcast tactical data to all platforms, some of which can only be reached on another medium (e.g., HF). The objective is to dynamically select intermediate nodes which can function as gateways between RF media. Net management overhead is to be minimized due to the generally low data rates of Navy radio links. This effort will include the development of software for use in the Naval Ocean Systems Center (NOSC, San Diego, CA) Communication Support System (CSS) test facility.

Phase I: Show technical/scientific feasibility of algorithms.
Phase II: Algorithm development.

N91-020 TITLE: Dynamic Net Membership

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques for adding and/or deleting network nodes in a Time Division Multiple Access (TDMA) network.

DESCRIPTION: Techniques need to be developed for assigning time slots to new net participants and reassigning slots to remaining participants after one departs. Algorithms for adding and deleting net participants in a TDMA battle group network are sought. Platforms needing to join the network need to be assigned permanent TDMA time slots. When platforms leave the network their slots need to be reassigned to the remaining net participants. Issues such as changes in cycle time and disruptions in net operation need to be addressed. This effort will include the development of software for use in the Naval Ocean Systems Center (NOSC, San Diego, CA) Communication Support System (CSS) test facility.

Phase I: Show technical/scientific feasibility of algorithms.
Phase II: Algorithm development.

N91-021 TITLE: Tactical Data Transmission Compression

CATEGORY: Exploratory Development

OBJECTIVE: Provide for data compression and data flow control methods to reduce data transfer volume, while maintaining or increasing actual information content transfer.

DESCRIPTION: This task seeks to define and develop the necessary functions and algorithms which will minimize the actual on-the-air data transmissions between Navy TADIL J units through control of message size and message flow control. The tradeoffs will include the development of minimum message flow modes relative to successful completion of specific platform missions. Benefits are to be shown relative to TADIL J, modes of operation of platform, and platform mission phase. Proposed algorithms must be suitable for incorporation in the current C2P architecture and host platform computers. This effort will include the development of software for use in the Naval Ocean Systems Center (NOSC, San Diego, CA) Communication Support System (CSS) test facility.

Phase I: Show technical/scientific feasibility of algorithms.
Phase II: Algorithm development.

N91-022 TITLE: Resource Management for Automatic Demand Assigned Multiple Access (DAMA)

CATEGORY: Exploratory Development

OBJECTIVE: Develop automatic time slot assignment algorithms for automatic DAMA including decision aids, queuing strategies and synchronization methods.

DESCRIPTION: The current DAMA satellite system does not include the feature to automatically assign time slots according the dynamically changing demand. This effort requires the simulation of expected events, understanding of the changing operating environment, and the definition and development of control algorithms and decision support systems. The effort should include evaluation of various control schemes over the order wire (inband and out of band), strategies to deal with new subscriber requests, congestion, impact of interrupting service for existing subscribers to reorganize channel allocations, evaluation of channel control frames other than Time Division Multiple Access 1 (TDMA1), strategies for database synchronization, operator support tools, and assurance of subscriber privacy. Proposed algorithms shall be developed and coded for use and evaluation in the Naval Ocean System Center (NOSC, San Diego, CA) test facility.

Phase I: Show technical/scientific feasibility of algorithms.
Phase II: Algorithm development.

N91-023 TITLE: Ship-to-Ship Video and Data Communications System

CATEGORY: Advanced Development

OBJECTIVE: Develop a secure LPI ship-to-ship data and audio/visual communications system based on CAINS technology.

DESCRIPTION: The CAINS system transmits LPI low power digital microwave signals from aircraft carrier to aircraft for navigational purposes. These signals are undetectable at distances of 5,000 meters or more from the transmitter. The objective is to develop ship-to-ship audio, data and video teleconferencing communications systems utilizing CAINS technology. The system should be capable of transmitting audio, T-1, and full motion color video simultaneously. The signals should be undetectable at distances greater than 10,000 meters from the transmitter. Consideration should be given to compensating for the relative pitch, roll, and yaw motions of the ships.

Phase I: Determine the feasibility of adapting CAINS technology to ship-to-ship communications.
Phase II: Develop a prototype system(s) suitable for potential Phase III follow-on.

N91-024 TITLE: A Non-Corrosive, Non-Volatile Replacement Battery for Search and Rescue Emergency Radios

CATEGORY: Engineering Development

OBJECTIVE: The objective is to develop a non-corrosive, non-volatile battery for use in search and rescue radios.

DESCRIPTION: All surface and sub-surface vessels are equipped with an emergency search and rescue radio with a lithium-sulphur dioxide battery installed. The battery requires special handling and storage, and has exploded aboard a surface ship causing equipment damage and personnel injuries. A battery is needed that can be handled and stored safely. This battery must meet requirements for safety, storage and extended operations beyond seventy-two hours. This battery must also be physically, electrically, mechanically, and functionally interchangeable with currently installed batteries that meet radio performance requirements. Safety requirements dictate that the search and rescue radios incorporate self diagnostic computer capability to pre-determine the status of the radio prior to emergency use requirement. The radio must provide a covert operational link which functions to restrict information and data which could support target acquisitions by enemy forces during emergency search and rescue operations. The current sensitive location information is available within the line of sight thirty mile range.

Phase I: Feasibility model to demonstrate operational capability.
Phase II: Service Test Models.
Phase III: Transition will be realized with a pilot production Phase II option.

N91-025 TITLE: High Speed LED-Based Optical Transmitter for Digital Communications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a high speed LED-based optical transmitter for use in military Local Area Networks (LANs).

DESCRIPTION: Advanced avionics architectures will feature Local Area Networks which operate at serial data rates approaching 1 gigabit per second. Currently available optical transmitters which operate at these speeds employ laser diodes which suffer from serious temperature problems due to the exponential temperature dependence of their threshold current. Moreover, they require complex and bulky sensing and feedback circuitry to stabilize their output over even a limited temperature range. LED transmitters do not suffer from these problems, but they are currently limited in bandwidth to several hundred megabits per second. The purpose of this effort is to develop a high speed LED-based optical transmitter suitable for operation in a military environment.

The transmitter must be capable of modulation at 1 gigabit and couple at least 100 microwatts of optical power into 100/140 micron graded index fiber. The transmitter input should be compatible with Emitter-Coupled Logic (ECL) levels. Initially the operating temperature should cover the range of 0-85 celsius with an ultimate goal of the full military temperature range. Technologies to be considered may include speedup drive circuitry and quantum well devices.

Phase I: Show technical feasibility of conceptual optical transmitter.
Phase II: Development of the optical transmitter.

N91-026 TITLE: Transputer Applications for Multiple Target Tracking in Anti-Submarine Warfare (ASW)

CATEGORY: Exploratory Development

OBJECTIVE: (a) Design and develop algorithms to partition the parallel components of a multiple target tracking problem, and (b) implement these components in hardware with the combination (number, type, and configuration) of transputers that best meet the performance and cost specification of a system.

DESCRIPTION: Since the ASW Systems employ a suite of diverse sensors to track multiple surface and subsurface targets in a cluttered environment, the computational requirements of track initiation and track maintenance can be enormous. In a barest form a central issue in multi-sensor, multi-target tracking is the assignment problem. It has been found that the amount of computer resources and computer time of conventional computers increases exponentially as the number of targets increase. The track-contact association is inherently a parallel task which is ideally suited for decomposition. The idea here is to exploit this high degree of concurrence using transputers (microprocessors with parallel architectures). The transputer architecture directly implements the process model of concurrence to describe parallel systems naturally and simply. The key feature of this application should be flexibility: transputers could be easily added as building blocks to transputer networks because of their modularity and synchronized point-to-point communication create a unified systems structure.

Phase I: Design and development of the software.

Phase II: Refine the design and selection of best alternatives, and integrate this product with the existing software and hardware tracking systems for ASW at some selected Navy facilities.

N91-027 TITLE: Network Security Study

CATEGORY: Research

OBJECTIVE: Investigate the security risk associated with a trusted End-to-End Encryption (E^3) system hosted on a trusted operating system.

DESCRIPTION: End-to-End Encryption (E^3) offers high assurance for message confidentiality and integrity in a network environment, even if the communication crosses several physical network boundaries by use of multinet bridges and gateways. Research is needed to be performed in which a trusted E^3 system is hosted on a trusted operating system configured on a network. The seriousness of the traffic flow security problem should be investigated and, if possible, measured or determined. Then the prevention of traffic flow leakage should be examined using methods such as link super-encryption, traffic padding, varied routing and controlled timing. Emphasis should be given to methods that have the least negative impact on the network capacity and message transmission speed, and to methods that can be performed as trusted operating system services so that the entire communication can be performed using trustworthy processes.

Phase I: Examine methods to determine the seriousness of the traffic flow security problem and techniques to prevent leakage.

Phase II: Implement and demonstrate those most promising E^3 methods which have the least negative impact permitting trust in the communications process.

N91-028 TITLE: Multilevel Computer Security Implementation Constraints on Operating Systems for Navy Warfare Systems

CATEGORY: Research

OBJECTIVE: To identify and analyze multilevel computer security implementation constraints on operating systems for Navy warfare systems.

DESCRIPTION: Navy warfare systems operate in very demanding tactical real time environments ranging from an embedded system to a widely distributed system. The operating systems must provide timely critical system resource control and guarantee predictable services to support Navy applications. The Navy has requirements for secure tactical computer systems. Multilevel computer security implementations will adversely impact operating system efficiency. A study is required to identify and analyze the constraints imposed on operating systems for multilevel secure environments in Navy tactical warfare systems. The study should analyze various implementation strategies for successful operating system performance in light of the identified constraints.

Phase I: Explore techniques to identify and analyze the constraints imposed on operating systems in multilevel secure environments.

Phase II: Conduct necessary research and demonstrate strategies for successful operating system performance.

N91-029 TITLE: Multiple Net Data Link

CATEGORY: Exploratory Development

OBJECTIVE: Study the feasibility and implement a working prototype of a multiple net data link tailored to Navy tactical data link needs guided by the Navy Tactical Data Link Plan.

DESCRIPTION: Present data links are limited to single nets. Tactical needs require multiple, as few as two, data links that can easily communicate with each other. Standard links are well established and existing hardware and software could be modified to meet this need, or new equipment could be specified if desired.

Phase I: Investigate the feasibility of multiple net architectures for existing Navy data links. Present and future equipment must be considered and minimal modifications are desirable if possible. Implementation could be in conjunction with modernization and improved capability. A preliminary design would detail the best architecture and implementation.

Phase II: Design multiple net data link using the output from Phase I. Existing hardware will be modified or new equipment will be designed and prototyped to test and demonstrate the data link net. Deliverables will include a design analysis, a complete design and documentation package, and hardware, modified or new.

N91-030 TITLE: Generic Modem for Data Terminal Set (GM)

CATEGORY: Exploratory Development

OBJECTIVE: Study of feasibility and implement a working prototype of a generic modem capable of performing various functions in a data terminal set used in standard Navy tactical data links. This includes, but is not limited to, Link-11, Link-4 and the Link-11 Improvement Program (LEIP) Single Tone.

DESCRIPTION: Present modems are limited to single functions. Tactical needs require multiple functionality to be able to adapt communication needs to changing situations. Standard data links are well established but existing modem hardware can only perform a single function. New functions could be specified if deemed desirable and sufficient processing to allow for product growth is desirable.

Phase I: Investigate the feasibility of multiple function architectures for Navy modems. Present and future equipment must be considered and modifications to existing equipment are desirable if possible. Implementation could be in conjunction with modernization and improved capability. A preliminary design would present the best architecture and implementation.

Phase II: Design a multiple function modem using the output from Phase I. Existing hardware will be modified or new equipment will be designed and prototyped to test and demonstrate the modem. Deliverables will include a design analysis, a complete design and documentation package, and hardware, modified or new.

N91-031 TITLE: VME Single Card Link-11 Monitor System (LMS)

CATEGORY: Exploratory Development

OBJECTIVE: Study the feasibility and implement a single card VME bus LMS that will perform all functions of the present hardware implementation.

DESCRIPTION: The fleet LMS is implemented in special hardware as a component of Link-11. Future Link-11 systems will be integrated in a VME bus computer and compressing component functionality onto single card computers would be extremely cost and space efficient. Sufficient processing to handle Link-11 Improvement Program Single Tone is necessary and additional processing to allow for product growth is desirable.

Phase I: Investigate the feasibility of a single card LMS implementation and identify the appropriate architecture. Any available technology may be utilized, however, 1750A is the standard Navy embedded language. Any ideas for improvements to LMS are welcome and will be considered.

Phase II: Design and construct a single card LMS prototype using knowledge learned from Phase I. VME bus form, fit and function compatibility is a must. Deliverables shall include, but are not limited to, a detailed design analysis, a design and documentation package, and one or more VME single card LMS implementations. Test procedures will be defined and test results documented in a final, comprehensive report.

N91-032 TITLE: Modular Ada Software Development for SPARC Station TM 300 Series

CATEGORY: Engineering Development

OBJECTIVE: The Navy's Command, Control, Communications, and Intelligence (C^3I) hardware and software architecture is being evolved utilizing the Navy standard desk top computer (DTC II) hardware and Ada software language. Software programs are currently being developed on other more costly and larger Navy standard hardware or special purpose processors. The DTC II or RISC-based SPARC Station 300 Series Graphic Workstation has the following computational power:

- 16-MIPS integer performance for computer intensive applications
- 26 Mflops double precision Linpack performance for enhanced speed of loading-point calculations
- 128 Kbyte virtual-address, write-through cache memory for maximum CPU performance
- 40 Mbytes on-board memory

Several software modules are to be converted to Ada and rehosted/integrated on the DTC II workstation to allow cost savings in that the procurement of the other Navy standard Navy hardware will not be required. Access to other platforms which are currently scheduled to receive DTC II hardware and are not scheduled or programmed to receive the other Navy standard hardware is also a major advantage to the Navy on this effort.

DESCRIPTION: Software modules which require conversion to Ada include those which process communications I/Os (i.e., OTCIXS, TADIX, TACINTEL, NAVMACS, etc.), Local Area Network (LAN) management and controller software. This effort would require the small business contractor to code this software in Ada language suitable for implementation on the DTC-II workstation in three phases.

Phase I: Includes the software coding and documentation in Ada.

Phase II: Includes the software coding and documentation in Ada.

Phase III: Includes testing the software at a government laboratory to verify its acceptability for use in Navy systems.

N91-033 TITLE: Advanced Systems and Concepts for Future Naval Warfare

CATEGORY: Exploratory Development

OBJECTIVE: Enhance Navy's future warfare capabilities in Space, C^3I, Undersea Surveillance and ASW.

DESCRIPTION: Navy is seeking new, innovative, high risk/high payoff ideas in technologies and/or advanced systems concepts that support Space, C^3I, Undersea Surveillance and ASW systems for the years 2005 and beyond.

Phase I: Proposal should address: a) the system concept or technology being proposed, b) the innovative operational utility in future Naval warfare, c) the scientific principal(s) involved (show quantative formulation where appropriate), d) the maturity of the technical discipline, and e) the work planned to demonstrate technical feasibility.

Phase II: Development of the requisite subsystem and/or new technology to realize the proposed system concept.

N91-034 TITLE: Critical-Time/Real-Time Database Management

CATEGORY: Research

OBJECTIVE: Develop critical-time/real-time database management capabilities that will provide the performance improvement demanded by mission critical applications with stringent processing/response requirements.

DESCRIPTION: The data requirements of mission critical Navy systems have been increasing dramatically. Navy C^3I systems must manage land, sea, airborne and space data elements. Driving such systems are significant requirements for maintenance of thousands of objects, discriminating the real threats among them, and tracking them with real time updates. Tactical weapons systems require performance in the highly real-time to critical-time performance envelopes. Autonomous sensor/weapon control systems must deal with an enormous quantity of unfiltered data coming in at very high data rates. Critical to the success of mission critical Navy systems is the ability to manage large (gigabit) databases in a fast, predictable and reliable manner. The demanding mission critical environment will become even more challenging due to a substantial increase in the amount of data to be considered as a result of new sensor systems and communications capabilities, and reduced reaction time resulting from increasingly sophisticated weapons that can minimize detection time. Response to critical-time/ real-time requirements for large databases is beyond the capability of currently available database management systems (DBMSs). Such DBMSs lack an awareness

of, and the ability to meet, the deadline and/or time-critical nature of the processing requirements. Additionally, currently available DBMSs are not able to offer the high throughput rates required by Navy systems. Existing Navy systems utilize a significant level of hand tailored assembly level code to meet these types of performance requirements.

Phase I: Identify research needed to develop the technology to permit database management systems to support the Navy's critical-time/real-time data management requirements.

Phase II: Implement the research identified under Phase I.

N91-035 TITLE: Local Area Network (LAN) Security

CATEGORY: Research

OBJECTIVE: Develop innovative approaches to achieve LAN security.

DESCRIPTION: The U.S. Navy is investing manpower and resources into the definition, standardization and acquisition of LANs for use on Naval ship and shore platforms. Some of these applications will require security protection in areas such as:

- Data Confidentiality - protection against improper disclosure
- Data Integrity - protection against alteration or destruction
- Access Control - protection against misuse of resources
- Traffic Padding - protection against traffic analysis
- Proof of Origin - protection against masquerading
- Proof of Delivery - protection against repudiation
- Proof of Originality - protection against reflection or replay

Innovative approaches are needed for the cost-effective provision of the above services while addressing issues such as the following:

- Impact of added security overhead upon network performance
- Techniques for key distribution
- Time to set-up a secure session
- ISO level in which to insert security mechanisms
- Advantages/disadvantages of symmetric (DES) versus asymmetric (RSA) keys

Phase I: Identify innovative approaches to achieve LAN security.

Phase II: Demonstrate LAN security.

N91-036 TITLE: Constraints and Systems Primitives in Achieving Multilevel Security in Real Time Distributed Systems Environments

CATEGORY: Research

OBJECTIVE: Study trusted distributed systems which operate over a heterogeneous collection of processors.

DESCRIPTION: This effort should produce a preliminary design for a distributed operating system and develop an initial proof-of-concept prototype to investigate the principal mechanisms that support distributed operating systems. Central to this research effort is the examination of the network server interaction locally and across the network. Issues of object name space, user and machine identification and authentication, exploitable covert channels, and configuration control should be addressed. A design for audit across the distributed system should be developed. Issues associated with strategies for data replication and remote node authentication within the distributed system should also be considered.

Phase I: Conduct analyses of trusted distributed systems which operate over a heterogeneous collection of processors.

Phase II: Produce a preliminary design for a distributed operating system and develop an initial proof-of-concept prototype to investigate the principal mechanisms that support distributed operating systems.

N91-037 TITLE: Low Probability of Intercept Sensor Network

CATEGORY: Advanced Development

OBJECTIVE: Development of design requirements for a Low Probability of Intercept (LPI) network of sensors which may be directly applied to design specifications of various types of sensors (infra-red, optical, ESM, acoustic, multi-static radars) for use in Naval and Marine Corps applications.

DESCRIPTION: Currently, the primary means of surveillance of hostile airspace is high-powered, mono-static radars. With the increasing capabilities of Anti-Radiation Homing Missiles (ARMs) and Anti-Ship Missiles, it is essential to significantly decrease the radiated signature of U.S. tactical forces. Additionally, with the scenarios of "Low-Intensity Conflict" (LIC) and/or deployment in the vicinity of "neutral" nations, it is desirable to have the capability to perform electromagnetically covert surveillance.

Phase I: Identify the critical technical issues which must be addressed and analyze the advantages and constraints associated with various techniques to accomplish "covert" surveillance.

Phase II: Include conducting system-level trade-offs of performance, technical risk, and relative cost of these system architectures. Phase II would culminate in development of specifications for key elements of the system such as data fusion, and appropriate sensors.

Phase III: Include the development of an Engineering Development Mode of an LFI Sensor Network.

N91-038 TITLE: Non-Cooperative Target Identification

CATEGORY: Advanced Development

OBJECTIVE: Design concept and experimental data to verify method for adding non-cooperative target identification capability to USMC and Navy long-range surveillance radars.

DESCRIPTION: Verifying identification of targets which are not squawking or confirming ID of squawking targets remains a highly desired capability for air defense sensors used for ground controlled intercept. Many techniques are available to provide this capability by significant augmentations to the radar which add auxiliary sensors and processors. A technique is sought which is integral to the various radars and does not result in greater radar transportable weight or require significant package alternation.

What is needed is a technique which enables a designated target ID to be determined without significantly impacting the on-going surveillance process. Operator interaction in the recognition process must be minimal; the recognition must be an aid to the operator, not a new functional process for him to perform. Display requirements must not perturb existing formats to any significant degree.

Phase I: Synthesize a cost-effective integrated concept for the various radars and propose a means to validate the concept through the use of real radar data exercising a simulation of the recognition technique.

Phase II: Implement and field-test an advanced development model of the proposed technique on the candidate radar.

N91-039 TITLE: Automated Training for the Integrated Undersea Surveillance System

CATEGORY: Engineering Development

OBJECTIVE: Develop a system to aid operator training for the Integrated Undersea Surveillance System.

DESCRIPTION: The Integrated Undersea Surveillance System consists of hardware and software for the purpose of processing large amounts of acoustic data. This process is labor-intensive in all its phases. The operators on which it depends are currently trained in a classroom by personnel who would otherwise be operating the system. Space and Naval Warfare Systems Command requests proposals for embedded automated training aids in the Integrated Undersea Surveillance System which will allow on-the-job training using real data as those data are processed. An embedded training capability would significantly reduce the manpower and funding required to provide formal operator training in a classroom environment. The training capability must be structured enough to allow for stand alone operation and individual system operator training, while being flexible enough to provide operators the capability to participate in simulated training exercises and scenarios. The training aids should require minimum oversight by previously trained operators.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review, and c) a brief and final report to the Navy project manager.

Phase I: Concept review and cost benefits study.

Phase II: Promising automation concepts will be implemented on a DTC-II provided as GFE for this development effort by PD-80 and installed and tested at a Navy facility. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-040 TITLE: Time-Frequency Representation Using the Wigner-Ville Distribution

CATEGORY: Advanced Development

OBJECTIVE: Develop and test and optimum time-frequency representation of sonar signals.

DESCRIPTION: The Lofargram has long been a standard means of representing sonar signals in a combined time-frequency presentation. The Lofargram represents a particular trade-off between the conflicting demands of resolution in the time and frequency domains. Recent theoretical work has suggested that an optimum compromise between demands of good resolution in time and frequency can be found, based on a generalized Wigner-Ville distribution but displayed on a Desk Top Computer (DTC-II) Cathode Ray Tube (CRT) versus the conventional paper display.

Each phase will require a) an initial brief including a program objective, actions, and milestone review, b) a final review, and c) a brief and final report to the Navy project manager. The concepts will be demonstrated at one of the Navy's Ocean Processing Facilities.

Phase I: Investigate this concept on real and synthetic data and attempt to transition practices currently in operational use (e.g., "walking the grams") from paper displays to high resolution DTC-II displays.

Phase II: Production of a real time display system, compatible with existing Navy systems, to demonstrate the potential Wigner-Ville distribution. Successful Phase II contractors will transition their technology into the Undersea Surveillance Program Research and Development Program.

N91-041 TITLE: Image Analysis, Automation and Detection for the Integrated Undersea Surveillance System

CATEGORY: Advanced Development

OBJECTIVE: Examine and develop image analysis, automation and detection techniques.

DESCRIPTION: The Integrated Undersea Surveillance System consists of hardware and software for the purpose of analyzing large amounts of acoustic data. This process is currently very labor-intensive in all its phases. Space and Naval Warfare Systems Command requests proposals to automate this system using advanced image analysis, automation and detection techniques. Proposals for automated image analysis and detection processes are solicited.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development program.

Phase I: Concept review, analysis study and high level design for the proposed category.

Phase II: Promising advanced image analysis and detection concepts will be implemented, installed and tested at a Navy facility.

N91-042 TITLE: Acoustic Communication for the Integrated Undersea Surveillance System (IUSS)

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate the application of acoustic communications systems concepts to provide improved tactical connectivity for Anti-Submarine Warfare (ASW) forces.

DESCRIPTION: Improved acoustic communications techniques are required to provide survivable and enduring ASW communications. This project will examine the potential for application of acoustic communications to IUSS as an alternate path for ASW users.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) final review and c) a brief and final report to the Navy project manager.

Phase I: Analysis will include a system design concept for integration of acoustic communications to ASW platforms, systems and sensors. The plan will include a survey of existing and planned IUSS/Fleet resources. IUSS system/subsystem improvements, acoustic conditions and environmental parameters/issues will be addressed. The feasibility of the proposed systems concept must be demonstrated.

Phase II: Encompass modeling, development, laboratory testing, validation and demonstration of the utility of the design concepts. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development program.

N91-043 TITLE: Meteor Burst Communications in Northern Latitudes

CATEGORY: Advanced Development

OBJECTIVE: Explore the feasibility of employing meteor burst communications to improve Integrated Undersea Surveillance System (IUSS) operations in northern latitudes of the Atlantic Ocean.

DESCRIPTION: Meteor burst communications technology offers reliable communications, consists of available off-the-shelf technology and represents a low-cost opportunity to initiate communications at distance of up to 1000 nautical miles.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Investigate the feasibility of employing meteor burst technology in northern latitudes by investigating and documenting the current capabilities of the technology. The results of this investigation shall be applied to designing a system which incorporates meteor burst technology into IUSS ships deployed in northern latitudes of the Atlantic Ocean. The design must address basic performance parameters (e.g., throughput, wait time) and should improve performance through proper system design (e.g., transmitter power, antenna gain, receiver sensitivity).

Phase II: Demonstrate the utility of the design through the testing and evaluation of the system in an operational environment. A test plan shall be developed and will include preparing test messages, verifying the accuracy of their transmission and determining the throughput and wait time involved in the transmission of these messages. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-044 TITLE: Advanced Signal Processing Techniques for the Integrated Undersea Surveillance System

CATEGORY: Engineering Development

OBJECTIVE: Develop advanced signal processing techniques to further the automation of the Integrated Undersea Surveillance System.

DESCRIPTION: The Space and Naval Warfare Systems Command is soliciting advanced signal processing algorithms to improve the following areas: a) reporting time as measured by time late, b) probability of detection and false alarm, and c) operator productivity and system automation. These areas are currently very labor-intensive. Space and Naval Warfare Systems Command requests proposals to automate these areas either in part or in hole. Proposed systems should significantly reduce the amount of time required to analyze data and to produce accurate reports.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Concept review, analysis study and high level design for proposed area.

Phase II: Promising automation concepts will be implemented, installed and tested at a Naval Ocean Processing Facility. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-045 TITLE: Acoustic Images From Active Sonar

CATEGORY: Advanced Development

OBJECTIVE: Produce an image of a target from active sonar data.

DESCRIPTION: Recent developments in high-speed computing have been exploited to build systems which can form images of aircraft from pulsed radar returns. The ability to form similar images of underwater targets, using one or more active sonar pulses, would be of great benefit to the Navy. Space and Naval Warfare Systems Command requests proposals to design, construct and demonstrate such a system.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Design effort, devoted to selecting transmitters, receivers, transmitted waveforms and signal processing algorithms.

Phase II: A prototype system will be constructed and tested against targets of interest to the Navy. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-046 TITLE: Automated Computer On-Line Library

CATEGORY: Advanced Development

OBJECTIVE: Develop an on-line library of information current in the Integrated Undersea Surveillance environment.

DESCRIPTION: Twenty years worth of pertinent information is provided to the Integrated Undersea Surveillance System Oceanographic Technicians in the form of text books and papers. The information is currently stored in handwritten notes. It would be extremely useful to the Navy to be able to provide this information to these Oceanographic Technicians from an on-line computer system. This would require a) determining which set of documents should be provided as on-line material, b) examining all results for site peculiarities, c) scanning or entering the pertinent information into a database, and d) providing the software capability to search and find any topic area by key words and titles.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Study should describe a method of performing this task which includes a basic list of documents and areas of interest and a high level design to be implemented in Phase II.

Phase II: Promising designs will be implemented, reviewed and tested at an operational Navy facility. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-047 TITLE: Non-Developmental Item Software Application to Undersea Warfare Systems

CATEGORY: Advanced Development

OBJECTIVE: Apply commercially available software to enhance Undersea Warfare Operational Systems to increase operator productivity, support data fusion and reduce training needs for military personnel in the areas of C^3I, undersea surveillance and Anti-Submarine Warfare (ASW).

DESCRIPTION: With no expected growth in naval personnel and a substantial increase in systems complexity, a greater burden has been placed on the operator. Operators need real-time access to a myriad of active and passive sensor data as well as an increased need to simultaneously view and image data. The Navy is seeking innovative concepts using proven, commercially available Non-Developmental Item (NDI) software for on-line interactive text, friendly interface design, and image capture and management or create undersea warfare computer systems. The purpose is to increase operator productivity, support data fusion and reduce training needs for military personnel in the areas of C^3I, undersea surveillance, and ASW. This research effort will provide a software package which will increase operator productivity and strengthen usability.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Show feasibility of the NDI software to improve operator productivity.

Phase II: Finalize the NDI software.

NOTE: It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-048 TITLE: Develop an All-Electronic Storage Medium

CATEGORY: Advanced Development

OBJECTIVE: Develop an all-electronic storage medium to replace mechanical disk drives.

DESCRIPTION: The project will include studies on short term and long term retention of data in a semi-conductor device to replace the existing data storage devices in the Integrated Undersea Surveillance System.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Identify promising technologies and assess their merits for this project.

Phase II: Construct a prototype system using off-the-shelf items where possible. The Phase II prototype should interface with a DTC-II workstation GFE during Phase II for demonstration. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-049 TITLE: Workstations in Future Warfare Systems

CATEGORY: Advanced Development

OBJECTIVE: Optimize workstations in future Naval warfare systems.

DESCRIPTION: The most far reaching developments in warfare systems design have been the advances in technology that make workstations so important to future warfare systems. It is anticipated that these workstations can be further improved. Areas of improvement include displays, where color-coding, display rates, screen size, survivability, security, maintainability and reliability can be improved. Future systems will require significantly increased operator productivity in tactical and surveillance operation modes, embedded operator training and reduced operator monotony and stress. Finally, future hardware and software should be common to all Navy systems in order to reduce acquisition and training time costs.

The purpose of this solicitation is to request proposals to improve workstations for future Navy systems. It also request proposals for an expert system which can a) evaluate systems currently fielded and b) analyze the Operator Machine Interface design of systems being developed. Optimization includes increasing probability of detection, classification and location; ensuring hardware and software commonality; reducing operator workload; improving operator response time; providing automatic error correcting; providing embedded training; overcoming the boredom associated with highly repetitive tasks; and reducing operator fatigue associated with current cathode ray tube displays. This effort includes applying analytical tools and methodology, tables, lists, charts, statistical and other data methods, and graphics to develop a cost effective Navy wide approach. This effort would be pursued as a general purpose Navy workstation study and design effort but would have significant application for the Integrated Undersea Surveillance System (IUSS) (i.e., Sound Surveillance System Program (SOSUS)/FDS).

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Should include background research resulting in a high level design to be developed further in Phase II.

Phase II: Construct a prototype workstation or expert system and demonstrate with real data at a Navy facility. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-050 TITLE: Towed Acoustic Array Shape Estimation

CATEGORY: Exploratory Development

OBJECTIVE: Explore techniques of accurately measuring relative hydrophone positions in very long towed acoustic arrays.

DESCRIPTION: Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Identify feasible schemes for sensing the position of hydrophones in very long acoustic arrays. Proposed techniques should include transmitter and sensor placement, processing algorithms and sensitivity analysis for key parameters.

Phase II: Implement the techniques and design an experiment for at-sea performance analysis. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-051 TITLE: Quantitative Analysis of Computer Assisted Acoustic Detection and Tracking Algorithms

CATEGORY: Advanced Development

OBJECTIVE: Measure the quantitative improvement realized by computer-aided algorithms in detecting and tracking acoustic targets. Phase I would develop performance criteria and an analysis method, with limited prototyping on synthetic and real ocean data. Phase II would entail analysis of a large volume of ocean data.

DESCRIPTION: The analysis would address both stable and dynamic targets at various signal-to-noise ratios, bearing rates and band widths. The performance analysis algorithm would be implemented on a laboratory computer suite of the offeror's design. Test data would be analyzed to validate the algorithm.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Develop a set of performance metrics which accurately quantify the value of a computerized detection and tracking system.

Phase II: Should be a high volume data analyses using ocean data from surveillance archives. A final report would be submitted summarizing the results of all data analysis and comparing the performance of all detection/tracking systems analyzed. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-052 TITLE: Active Sonar Operator Training Workstation Concepts

CATEGORY: Advanced Development

OBJECTIVE: The objective of this topic is to explore innovative methods of training active sonar operators. Techniques should include methods for building operator confidence through interaction with simulated and real work data sets of varying complexity.

DESCRIPTION: Active sonar is the merging technology for ASW systems of the future. The active sonar problem presents the operator with a complex set of sonar systems and environmental operating parameters. Ocean clutter presents the operator with false detections which will have to be eliminated through both operator identification and application of new technology. This topic is to explore innovative techniques for training operators to deal with this new technology. Workstation based techniques which present the operator with an interactive learning environment and which build confidence and measure effectiveness are needed. Training techniques should include both monostatic and multistatic systems and be usable across multiple platforms.

Phase I: Show ability of training techniques to build operator confidence.

Phase II: Product development.

N91-053 TITLE: Machine Assisted Anti-Submarine Warfare (ASW) Passive Acoustic Classification System

CATEGORY: Advanced Development

OBJECTIVE: Develop a machine assisted ASW passive classification system.

DESCRIPTION: Machine assisted ASW passive classification systems have been under development for a number of years. They have seldom produced the spectacular results which had been promised. One of the reasons for this is that real experts in classification have not built up the classification database and procedures used in these systems. In this task, it is desired that businesses with experts in submarine classification build an innovative database and set of rules which will help acoustic operators to improve their ability to classify submarines, with primary emphasis on distinguishing submarines from anything else.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Compile algorithms which will classify submarines, based on the experience of experts. This will be demonstrated with a number of taped submarine signals.

Phase II: Code the classification algorithms generated in Phase I in an interactive computer system and demonstrate the classification capability in real time with recordings of signals from actual submarine encounters. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-054 TITLE: Development of Fluctuation Parameters for Use in Anti-Submarine Warfare (ASW) Acoustic Performance Prediction Models

CATEGORY: Advanced Development

OBJECTIVE: Measure characteristics of ocean propagation and noise and determine fluctuation parameters to be used in ASW acoustic performance prediction models.

DESCRIPTION: The acoustic performance prediction models for most ASW systems use the fluctuation properties of acoustic propagation and noise as an important feature in determining performance. Many of the models have been validated only to the extent that there is provision for using these statistical properties, with the operator providing the appropriate parameters. Validation of the correct values to use for these parameters has not been completed.

There is a need to gather sufficient acoustic data and provide an innovative approach to measuring its statistical properties. This would include the mean and variance and also the short term, medium term and long term fluctuation

properties. Under this task, existing data will be identified and analyzed, test plans will be generated for gathering additional data, data will be gathered and analyzed and the statistical properties will be determined.

Each phase will require a) an initial brief including a program objective, actions and milestone review, b) a final review and c) a brief and final report to the Navy project manager.

Phase I: Perform a survey of existing data and identify those suitable for analysis. Additional data needed will be specified, and data gathering plans will be generated. In addition, a small amount of data will be analyzed and a data analysis plan will be generated.

Phase II: Analyze existing data identified in Phase I and gather and analyze additional data. The mean, standard deviation and associated fluctuation properties of propagation loss and ambient noise will be determined for immediate application to existing performance prediction models, along with any generalizations or caveats which will describe the limits of its application. It is anticipated that successful Phase II contractors will transition their technology into the Surveillance Direction System Research and Development Program.

N91-055 TITLE: High Assurance Trusted Systems

CATEGORY: Research

OBJECTIVE: Investigate new approaches for achieving high assurance for trusted systems that accommodate innovative designs.

DESCRIPTION: The Trusted Computer System Evaluation Criteria requirements for A1 systems (the highest rating specified) call for proof that a Formal Top Level Specification (FTLS) of the Trusted Computing Base (TCB) is consistent with the security policy model of the TCB and a mapping of the FTLS to the TCB code. Experience is showing that a combination of verification tool limitations and difficulty in managing the disparity of abstraction level between FTLS and code, is having a negative impact on A1 system design and performance. A1 systems are being designed very conservatively in order to facilitate verification constraints, with the conservative design having a negative impact on system performance and cost. New approaches need to be investigated for achieving high assurance for trusted systems that accommodate innovative designs for high performance. The new techniques should be clarified and validated through application to assure security critical properties of software modules of novel design. Techniques shall be investigated, developed, and validated to provide high assurance of high performance trusted systems.

Phase I: Innovative techniques to assure security critical properties of software modules.

Phase II: Implementation and demonstration of the technique(s).

N91-056 TITLE: Characteristics of Processing Elements with Respect to Multilevel Security

CATEGORY: Research

OBJECTIVE: Research the impact that the requirement to support the implementation of highly secure systems has on the architecture of the processing elements.

DESCRIPTION: Navy warfare systems must address the conflicting requirements of ensuring that all information necessary for mission performance is available but that access to classified information is controlled, while providing a level of system performance adequate to successfully achieve mission objectives. Experience is indicating that provision of high levels of security in INFOSEC systems has a negative impact on system performance. Advanced architectures are now emerging, such as array processors, database machines and dataflow machines that offer the potential to enable the Navy to design advanced systems to meet future operational threats. Research is required to: 1) analyze the impact that implementation of highly secure systems has on the architecture of the processing elements, 2) analyze the role that the architecture of the processing element(s) (ranging from a single chip to massively parallel architectures) plays in the design of secure systems, 3) identify architectural characteristics of processing elements that are either required for or supportive of achieving high levels (B3/A1) of multilevel secure systems, and 4) identify the tradeoffs between implementing security features in hardware, software and a combination of the two. Ideally the research will quantify the tradeoffs with respect to processing speed and throughput.

Phase I: Analytical effort to examine processing element features with respect to incorporation of security.

Phase II: Demonstration of effect of processing elements incorporating security on system performance and quantify trade-offs.

N91-057 TITLE: Security Features for Workstations

CATEGORY: Research

OBJECTIVE: Investigate techniques to develop highly trusted security features for workstations.

DESCRIPTION: Current workstation technology allows for security at the B2 level. Improvements on this are difficult due to the nature of the architecture and use of a workstation. Efforts at developing a highly trusted workstation in the past have been incompatible with most commercial software due to unique operating systems, while efforts using standard operating systems have been unable to achieve the necessary security levels. Other areas needing research are in server and window management techniques.

Practical use of workstations in a trusted environment will require high levels of security (B3 or A1) while being compatible with existing operating systems and applications software. Research is required to: 1) provide security features for all components of workstations (i.e., operating system, window manager, data retrieval, etc), and 2) provide compatibility to existing workstation software.

Phase I: Analyze security features of workstations and determine effect on data entry/data retrieval capabilities.

Phase II: Demonstrate security features of workstations using modern man-machine interfaces such as windows.

N91-058 TITLE: Technology to Establish and Support the Role of Man in Computer Security Systems

CATEGORY: Research

OBJECTIVE: Develop technology and methods to ensure secure access to information residing in compartmented databases.

DESCRIPTION: Navy computer based systems need appropriate security features to ensure that all information necessary for performance is available but that access to classified information is controlled. The driving need is to ensure that the required information is available but is not compromised. Information residing in special compartmented information databases must be transferred to general service users who need it. Since this transfer is currently performed by human controlled interfaces, developers of systems must be provided with the means of ensuring that human performance does not impair the flow of information nor compromise the security of the information. Current system design concepts identify a critical role of man in system operation without the requisite technology to support these assigned roles. Problems of impaired vigilance, confusion, boredom, overload, stress, and inadequate motivation serve to degrade the performance of human operators in routine and continuous activities. The research should address the following: 1) human performance limitations in allocating system functions to man or machine; 2) the design of system displays, software and procedures to enhance human performance while compensating for human limitations; 3) quantify the problems associated with impaired vigilance, confusion, boredom, overload, stress, and inadequate motivation, and 4) provision of intelligent decision aids to assist and support the performance of human functions.

Phase I: Conduct analytical effort to identify technologies supporting the role of man in computer security systems.

Phase II: Demonstrate the requisite technologies.

N91-059 TITLE: Expert System for Multilevel Security

CATEGORY: Exploratory Development

OBJECTIVE: Propose, design and develop an advanced decision aid to assist and support the performance of human functions in multilevel secure systems.

DESCRIPTION: Navy computer based systems need appropriate security features to ensure that all information necessary for performance is available but that access to classified information is controlled. Current system design concepts identify critical roles for human operators in secure system operation (e.g., for information fusion and reclassification, for transferring information in a compartmented database to general service users, etc.). Problems of impaired vigilance, confusion, boredom, overload, stress, and inadequate motivation serve to degrade the performance of human operators in routine and continuous activities. Artificial Intelligence (AI)/expert system technology makes the development of "advanced" decision aids which can perform logical evaluation of the information feasible. The development of such AI based decision aids differs from that of conventional decision aids in that they incorporate the logic or "knowledge" of experienced users rather than just mathematical algorithms. Expert system technology is promising in that it offers the potential to capture the knowledge of experienced personnel, and to off load the human operator by evaluating the information and making recommendations. Research is required to investigate the applicability of artificial intelligence technology to the domain of multilevel security. The research should identify areas where expert systems could significantly contribute towards achieving secure systems, and select one or more areas for detailed definition, design and

implementation of a prototype intelligent display aid.

Phase I: Investigate applicability of artificial intelligence technology to multilevel security.

Phase II: Demonstrate expert system(s) as applied to multilevel security in Navy systems.

N91-060 TITLE: The Inference Problem in Multilevel Secure Database Management Systems

CATEGORY: Research

OBJECTIVE: To propose and investigate possible solutions to the inference problem which occurs in Multilevel Secure/Database Management Systems (MLS/DBMSs).

DESCRIPTION: It is possible for users of any DBMS to draw inferences from the information that they obtain from the databases. The inferred knowledge could depend only on the data obtained from the database system. The inference process can be harmful if the inferred knowledge is something that the user is not authorized to acquire. A user acquiring information which he is not authorized to know has come to be known as the inference problem in database security. In a multilevel secure environment, the users are cleared at different security levels and they access a multilevel database where the data is classified at different sensitivity levels. Security violation by inference occurs in multilevel databases if a user acquires unauthorized information from information he has obtained by either querying the database, updating the database, examining the metadata, or some combination of those actions supplemented by some real world knowledge. In a multilevel environment, unauthorized information is any information which is classified at a level that is not dominated by the user's level. Providing a solution to the inference problem, where users issue multiple requests and infer unauthorized knowledge, is beyond the capability of currently available MLS/DBMSs. Research is needed to minimize the risk of security violations by inference in MLS/DBMSs.

Phase I: Identify possible solutions to the inference problem in MLS/DBMSs.

Phase II: Demonstrate solutions to the inference problem.

N91-061 TITLE: Placement of Network Security Services for Secure Data Exchange

CATEGORY: Research

OBJECTIVE: Determine the security services required to address Navy threats.

DESCRIPTION: ISO 7498-2 identifies five basic security services: 1) access control, 2) authentication, 3) data confidentiality, 4) data integrity, and 5) non-repudiation. These services provide assurance against the security threats of unauthorized resource use, masquerade, unauthorized data disclosure, unauthorized data modification, and repudiation, respectively. This effort is to address the layers within the ISO OSI Basic Reference Model, ISO 7498, where it is appropriate to apply security services for Navy applications. The distinction is to be made between Local Area Networks (LANs) and Wide Area Networks (WANs). For example, at Layer 2, a WAN is a set of discrete, point-to-point links. Data received at one endpoint of a link can be assumed to have come from the other end of the link. This is not the case at Layer 2 of the LANs and Layer 3 of the WANs. The nature of data transmission in Layer 2 of WANs and the associated risks do not require security services to counter the threat of masquerade and unauthorized resources use. However, these threats must be addressed at Layer 3 of WANs. What is needed is a thorough analytical effort that addresses the security characteristics that should be included in each of the seven layers of the ISO OSI model for both LANs and WANs, taking into account features that are important to the Navy such as bandwidth, speed, survivability, reconfigurability, etc.

Phase I: Analyze security characteristics that should be included in each of the seven layers of the ISO OSI model for both LANs and WANs.

Phase II: Demonstrate a sub-set of the security features in selected levels of the ISO OSI model.

N91-062 TITLE: Composibility Constraints of Multilevel Secure Systems

CATEGORY: Research

OBJECTIVE: Research into techniques for achieving verifiable security levels when aggregating and integrating trusted elements, components, and sub-components.

DESCRIPTION: Current Information Security (INFOSEC) systems are networks of interconnected processing elements and databases connected to devices which allow human operators to interface with the data and computing resources. The collection of processing elements typically represent a heterogeneous mix of architectures, capability and classes of trust. The concept of a

Trusted Computer Base (TCB) was initiated when computer systems were basically monolithic systems consisting of a mainframe or host computer which interfaced to the users by directly connected unintelligent terminals. These terminals had a unique I/O port or were multiplexed to a single port in such a way that the host computer knew which terminal or group of terminals it was talking to by knowing the physical port to which the terminals were connected. Present computer systems are networks constructed with many processing elements which may or may not include a host computer. Local Area Networks (LANs) have replaced the direct connections. This effort should address the issues/constraints associated with developing trusted systems through the combination and integration of trusted components such as trusted operating systems, trusted Database Management Systems (DBMSs), and secure LANs. A composibility model is to be developed which will allow an evaluation of the security properties of a combination of trusted components whose individual security properties have been evaluated separately.

Phase I: Analyze issues/constraints in system development associated with combining trusted components.

Phase II: Demonstrate a subset of the effect of combining trusted components in the system development process.

NAVY MEDICAL RESEARCH AND DEVELOPMENT COMMAND

N91-063 TITLE: Isolation and Characterization of Proteins from Campylobacter Jejuni, Campylobacter Coli and Other Important Enteric Pathogens for Oral Immunization

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate ability to isolate and characterize immunologically relevant proteins from bacteria for rapid diagnosis and immunization. The goal is to provide quantities of material for laboratory and field testing.

DESCRIPTION: Immunization against enteric infections involves priming the local immune environment against the antigens of the infecting agent. For an intestinal infection, such as is seen in Campylobacter species and other enteric infections, the priming (inductive) sites are the Peyer's patches, small lymphoid nodules located in the small intestine. Considerable cross reactivity exists among the antigens of enteric pathogens and normal host flora of the small intestine. It is important, therefore, to identify antigens unique to the immunizing strain which are recognized by intestinal (IgA) antibodies of protected animals. We have shown that animals can be protected against infection with immunizing organisms. A need exists for the identification and preparation of protective proteins specific for strains of Campylobacter species or other important enteric pathogens. Proteins isolated by the offeror will be tested for their ability to elicit immune responses, such as T-cell and antibody reactivity, and these responses compared to those in animals immunized by infection. Additional material will be used for experimental immunization and rapid diagnostic techniques. The offeror must provide capability in Western Blotting, ELISAs, as well as FPLC or preparative gel electrophoresis techniques for the isolation of proteins of selected strains of Campylobacter species.

NAVAL AIR SYSTEMS COMMAND

N91-064 TITLE: Data Compression Schemes for UAV Sensor Data

CATEGORY: Exploratory Development

OBJECTIVE: To develop and implement data compression schemes to support near-real-time transfer of UAV sensor data on limited bandwidth data links.

DESCRIPTION: One of the primary missions for non-lethal unmanned aerial vehicles (UAVs) is near-real-time reconnaissance in a hostile environment. To perform this mission the UAV may use an imaging system such as a video camera. The video data is transmitted through an RF data link to the UAV controller. The techniques used to make a data link resistant to jamming may reduce the data link transfer capability to 1/20 of the rate at which data is collected by the sensor. Techniques and/or algorithms which would compress the sensor data to match the link data rate are required. Data compression, expansion and display are required in near-real-time.

Phase I: Demonstrate feasibility of a near-real-time data compression and expansion scheme which would allow transfer of video data on a 50K Baud stream. Efforts shall be reported in a Phase I final report.

Phase II: Develop a prototype system to demonstrate the proposed scheme.

N91-065 TITLE: Ultra Wideband (UWB) Radar/Data Link

CATEGORY: Exploratory Development

OBJECTIVE: Develop small, lightweight, survivable UWB radar for potential use as a data link. This approach would reduce payload cost and weight, while increasing operability, maintaining covertness and providing a wide bandwidth survivable data link.

DESCRIPTION: Current generation data links are susceptible to enemy countermeasures, can be detected, may highlight the unmanned aerial vehicle's (UAV's) position to enemy air defenses and provide a poor cost/performance tradeoff for UAV's. The purpose of this project is to demonstrate the feasibility of using UWB/Impulse radar techniques for a UAV data link.

Phase I: Study to determine the feasibility and characteristics of a UWB/Impulse radar data link and the design for a proof-of-concept demonstrator for UAV application.

Phase II: Fabricate a proof-of-concept design and experimental verification of the approach used.

N91-066 TITLE: Status Boards for Use with Air Traffic Control Radars on Aircraft Carriers and Amphibious Ships

CATEGORY: Advanced Development

OBJECTIVE: To provide an automated status board system for use with the Carrier Air Traffic Control (CATC) and Amphibious Air Traffic Control (AATC) Direct Altitude Identity Readout Systems. Existing status boards are out-moded, manpower intensive to maintain and not user friendly to update.

DESCRIPTION: In addition to controlling aircraft, CATC Center and AATC are information gathering operations. Information status boards are used for both planning and action. They must be accurate and continuously updated. The present system of requesting, relaying, posting and updating information is too slow, cumbersome, time consuming and not always 100 percent accurate. The present status board now requires six board writers to accomplish the work required to update and maintain. A new system is required to alleviate these problems including a fail safe back up capability.

Phase I: Study outlining the approach which will be undertaken to pursue the requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to convert one government furnished status board and deliver it to the government for testing.

N91-067 TITLE: Advanced ESM Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop new ESM subsystem architectures and signal processors to detect and effectively handle modern radar waveforms, potential radar reserve modes and modern ECM jamming waveforms.

DESCRIPTION: S-3 aircraft are currently using the ALR-76 system to perform EW related functions. The primary purpose is to develop improved ESM subsystem architecture and signal processing techniques which can be added to the current system to handle hostile environments expected in the 1990s and later.

Key technical problems are signal detection, sorting and classification of modern radar waveforms. Also, the improved ESM system should handle potential radar reserve modes and modern ECM jamming waveforms.

Phase I: Develop improved ESM subsystem architecture and signal processing concept, critical technical tradeoff analysis, and determine measures of effectiveness in simulated environments.

Phase II. Demonstrate critical technical elements associated with the enhanced EW system and quantify expected performance in S-3 aircraft operational systems.

N91-068 TITLE: Radar ECCM Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop radar ECCM techniques to detect and eliminate ECM noise jammer, repeater jammer, and transponder jammer signals from radar target track files

DESCRIPTION: S-3 aircraft are currently using the high resolution AN/APS-137 radar system for surveillance and target tracking functions. The fundamental purpose of this development effort is to develop new ECCM techniques for the APS-137 radar system to defeat modern ECM systems. ECM systems include repeater jammers, transponder jammers and noise jammers. Currently radar track files are overflowing with real targets and active ECM false targets. These ECM false targets come from noncoherent and coherent ECM jamming systems.

The basic technical problem is to discriminate and eliminate active ECM signals and leave only true target returns in the radar track files. This capability implies optimal use of radar assets and fire control system assets for targeting purposes.

Phase I: Develop basic ECCM technical concept, technical tradeoff analysis, simulation of basic ECCM discrimination technique, and determine radar target/ECM signal discrimination improvements. Also, an improved APS-137 radar architecture configuration will be developed which includes the new ECCM discrimination technique.

Phase II: Demonstrate the technical feasibility of the new ECCM discrimination technique for the APS-137 radar.

N91-069 TITLE: Supersonic Conformal Radomes Covering 2.0 Thru 100 GHz

CATEGORY: Advanced Development

OBJECTIVE: To develop and build antenna radomes which can withstand supersonic shock waves, large temperature variations, all environmental conditions of a Naval fighter aircraft or missiles and be electronically transparent from 2 to 100GHz. If successful, the radomes and/or materials would be used as the advanced radar warning receiver antenna radomes.

DESCRIPTION: Environmentally suitable aircraft antenna covers are available for the conventional microwave frequency region of 0.1 to 8.0 GHz. New requirements exist to extend antenna performance to 100 GHz. The purpose of this project is to develop new dielectric material or extend the capability of existing antenna cover materials to provide the desired environmental and electrical performance.

Phase I should consist of a materials study intended to identify the candidate antenna cover materials, their properties and availability/producibility.

Phase II should provide material samples along with appropriate environmental and electrical test data. The material sample(s) should be in the form of a usable antenna cover. The design drawing for the test cover(s) will be provided by the government as part of this phase.

N91-070 TITLE: Automation Tradeoffs Analysis Tool

CATEGORY: Exploratory Development

OBJECTIVE: Analyze, design, and prototype a tool for evaluating the costs and benefits of automating various functions within an unmanned aerial vehicle (UAV) system.

DESCRIPTION: Current generation UAV systems depend heavily upon man-in-the-loop operations for many of their functions (e.g., mission planning, air vehicle control, sensor control and interpretation, etc.). With the manpower drawdown and increasing application of expert system technologies, there will be significant opportunities for automating many of the critical UAV functions. A tool is needed to aid in determining which functions should be automated, how the interface with the operator should be redesigned to reflect this automation, and what the payoffs are in terms of system performance, to optimize design investments. This tool would involve several components. First, there would be a simulation of the UAV system and its subsystems, including the man-machine interfaces. Second, a human operator model is necessary, to project the impact of changes in system design on operator performance. Third, there must be a simulation of the combat environment, to provide a context for determining relative system performance and examining tradeoffs in a variety of mission situations. The development of this Automation Tradeoffs Analysis Tool would be divided into two phases.

Phase I: Design study conducted to establish the system architecture including the structure and interactions of the component models.

Phase II: Fabricate a prototype system for experimental verification and validation of the concept.

N91-071 TITLE: Helicopter Main Rotor Blade Elastomeric Dampers

CATEGORY: Advanced Development

OBJECTIVE: To study the application of advanced materials to solve the problem of helicopter main rotor blade damper failure.

DESCRIPTION: The SH-60B helicopter has experienced excessive damper failure due to the materials used and the design of the damper system.

The contractor will study alternate main rotor blade systems and materials for application to the SH-60B and other Naval helicopters in Phase I.

Phase II will consist of testing the concept of design and materials determined to be optimum in Phase I.

N91-072 TITLE: Helicopter Main Rotor Blade Pitch Change Rod End Bearings

CATEGORY: Advanced Development

OBJECTIVE: To find an alternate material for SH-60B Pitch Change Rod End Bearings. If successful, the Navy will save money used to buy spares and increase operational availability of SH-60B helicopters.

DESCRIPTION: Pitch change rods are used to change the angle of attack of the main rotor blades. The rods rotate around end bearings, which wear out rapidly. Each time one of the end bearings (8 bearings per rotor head) is replaced a post maintenance check flight must be conducted, keeping the aircraft from operational flights.

The contractor will research applications of advanced materials to increase the rod end bearing life.

N91-073 TITLE: MV-22/HV-22 Weapons System Integration and Armament Control

CATEGORY: Engineering Development

OBJECTIVE: To develop a Stores Management System (SMS) integrating weapons loadout capability with the helmet mounted display/sight (HMDS) in the V-22. After a successful system architecture is defined an engineering development model would be built and flight tested on a V-22. If successful, the goal would be to incorporate the system.

DESCRIPTION: There exists an outstanding operational requirement to incorporate defensive armament on the V-22. Currently the projected armament includes the following: turret mounted 50 caliber machine gun; two to four Stinger missiles; two Sidewinder and/or Sidearm missiles; two to four Sparrow missiles. The SMS will be the aircraft avionic subsystem that controls and monitors the operational status of installed weapons and provides and manages the communication between affected aircraft subsystems. This system architecture will split the Stores Management Control Unit into separated units into different aircraft areas. These units will be interconnected with a MIL-STD-1553B bus and a wideband signal network (for video, audio, RF and pulse signals). The aircraft subsystems that will be managed on these networks, will be a HMDS, a Forward Looking Infrared and threat warning equipment. The goal of this systems architecture is to minimize flight crew work load and maneuvering and deviation from preplanned flight path while still allowing the crew to meet the threat. This is of particular importance when approaching a landing zone or a strike rescue pickup.

Phase I should consist of a system architecture study which will be undertaken to pursue the requirements addressed above with sufficient data to demonstrate feasibility.

Phase II should use the approach outlined in Phase I to develop an engineering model and deliver it to the government for testing.

N91-074 TITLE: AH-1W Attack Helicopter Detectability Reduction

CATEGORY: Advanced Development

OBJECTIVE: Develop methods to reduce detectability of the AH-1W aircraft. Successful reduction methods could lead to prototype development and testing.

DESCRIPTION: The US Marine Corps, through new production and a block upgrade modification program, will achieve an all AH-1W attack helicopter fleet by the mid-1990s. This aircraft must remain capable of meeting the threat well into the 21st century. Increasing operational commitments require a reassessment of AH-1W detectability, which addresses, as a minimum, materials and systems in the following areas: (1) infrared (IR) signature; (2) radar cross section (RCS)/low observables, including fuselage/rotor shape and angles; (3) electromagnetic emissions; (4) visual features, including surface treatment and rotary-wing unique features; and (5) acoustic levels, including both vertical and forward flight.

Phase I: Design/trade-off study which evaluates the application and availability of advanced technology.

Phase II: Develop simulation models to demonstrate selected detectability reduction approaches.

N91-075 TITLE: AH-1W Attack Helicopter Maintenance/Manpower Reduction

CATEGORY: Advanced Development

OBJECTIVE: Develop methods to reduce maintenance and associated manpower requirements for the AH-1W aircraft. Successful reduction methods could lead to development of technical documentation and training material.

DESCRIPTION: The US Marine Corps, through new production and a block upgrade modification program, will achieve an all AH-1W attack helicopter fleet by the mid-1990s. This aircraft must remain capable of meeting the threat well into the 21st century. Improving the AH-1W maintenance process--with attendant manpower, documentation and reporting requirements--is an area requiring focused attention.

Phase I: Investigate and evaluate the AH-1W maintenance process and development of design/trade-off studies which report these results. The report also will offer recommendations concerning methods for improving the process, along with implementation plan(s).

Phase II: Implement appropriate technical documentation and training material.

N91-076 TITLE: AH-1W Attack Helicopter Cockpit Workload Reduction

CATEGORY: Advanced Development

OBJECTIVE: Develop recommendations to reduce pilot and copilot/gunner cockpit workload in the AH-1W aircraft. Successful reduction methods could lead to development of computer simulation models and ultimate prototype development/testing.

DESCRIPTION: The US Marine Corps, through new production and a block upgrade modification program, will achieve an all AH-1W attack helicopter fleet by the mid-1990s. This aircraft must remain capable of meeting the threat well into the 21st century. Naval Aviation Board of Inspection and Survey Yellow Sheet Reports identify cockpit design/integration deficiencies which range from man-machine interface issues such as critical field of view blockage and increased crew workload to those problems associated with aircraft ingress/egress. Such deficiencies jeopardize crew safety and preclude realization of enhanced mission capabilities.

Phase I: Investigate and evaluate cockpit workload, which will be documented in design/trade-off studies. The report also will offer recommendations to reduce this workload or methods that could reduce workload. Yellow Sheet Reports will be available to those firms possessing a security clearance of confidential.

Phase II: Develop selected computer simulation model(s), if applicable.

N91-077 TITLE: Advanced Aircraft Coating Removal

CATEGORY: Advanced Development

OBJECTIVE: Develop processes and methodologies for the removal of aircraft coatings that are environmentally benign. Such processes must be technologies that have some already developed applications related to paint removal. Suggested processes include but are not limited to ultrasound, flashlamp, ultraviolet radiation, etc. The process cannot use hazardous chemicals or energetic blasting media to remove aircraft paint.

DESCRIPTION: Current and anticipated environmental regulations do not favor the traditional chemical stripping of aircraft coatings. Energetic blasting methodologies are considered limited due to attendant structural damage and the need to dispose or recycle the hazardous blasting media wastes. Alternative innovative technologies are sought which will result in a controlled removal of aircraft paint without the generation of hazardous wastes. Naval aircraft paint systems consist of an epoxy based primer and a polyurethane topcoat. Substrate materials include aluminum, titanium, and graphite-epoxy composites.

Phase I: Selection and development of the most promising coating removal candidate with a small scale demonstration of the removal process on sample panels with the aircraft coating system. Phase I must show effective coating removal without substrate harm.

Phase II: Consists of a scale-up of the operation to determine the operational and industrial effectiveness of the process as well as its potential cost-benefit. Contractor should plan to work closely with a Naval Aviation Depot during this phase in implementing the full scale process.

N91-078 TITLE: Solvent Free Coating Application

CATEGORY: Exploratory Development

OBJECTIVE: Develop processes and methodologies for the application of aircraft coatings and corrosion inhibitors without the use of cut-back solvent technologies. Aircraft coatings, corrosion inhibitors, and spray treatments make use of volatile solvents as application media. The use of such solvents is becoming increasingly restrictive. Alternate innovative technologies are needed to facilitate quality application without generating solvent air emissions.

DESCRIPTION: Current and anticipated environmental regulations do not favor the traditional solvent medium for coating and surface treatment applications. While advances are being made in high coating solids technologies, there may be an upper limit of the percentage of solids in coatings and other materials similarly applied. An innovative technology program is sought for the introduction of new methods/media for application of the above materials. High temperature application processes are limited due to the temperature sensitivity of the materials being applied and the various substrate materials that are to be treated.

Phase I: Selection and development of the most promising material application candidate technology with a small scale demonstration of the process on sample aircraft substrate panels. Phase I must show effective material application without substrate harm and with satisfactory performance.

Phase II: Consists of a scale-up of the operation to determine the operational and industrial effectiveness of the process as well as its potential cost-benefit. Contractor should plan to work closely with a Naval Aviation Depot during this phase in implementing and evaluating the full scale process.

N91-079 TITLE: Biotechnological Processes to Strip Polyurethane Paint from Naval Aircraft

CATEGORY: Exploratory Development

OBJECTIVE: Develop a biotechnological process to strip polyurethane paints form Naval Aircraft

DESCRIPTION: Paints used on Naval aircraft have a polyurethane carrier for the pigment. Current practice, which does not meet EPA requirements, is to strip these paints with a methylene chloride stripper. Mechanical methods are also being considered but are not of interest here. It is desired to develop a biotechnological method to strip Milspec paints (such as Mil-C-83286) used on Naval aircraft.

Phase I: Demonstrate that microbial products such as surfactants, or enzymes, can strip paints at an acceptable rate and be consistent.

Phase II: Proceed to enhance efficacy and produce reasonable volumes of biological product which will have reasonable performance characteristics, shelf life, temperature range, and so on to make a product with satisfactory application and industrial properties.

N91-080 TITLE: Impact Damage Detection for Composite Aircraft Structures

CATEGORY: Advanced Development

OBJECTIVE: To develop a rapid detection method for field inspection of aircraft composites for low velocity impact damage. The system developed must be able to inspect both the upper and lower surfaces of wings and horizontal stabilizers, as well as vertical stabilizers.

DESCRIPTION: Current impact damage non-destructive evaluation methods to inspect composite materials are varied, and each method has specific limitations. Ultrasonic scanning devices have proven very reliable and sensitive to low energy impact damage. Simple portable modules have been made for field use. However, these systems are typically manual and tedious to use, and require significant operator care to ensure full area scanning.

Moire Methods have been proven reasonably effective on flat surfaces, but can only inspect a few square inches at a time, and results are difficult to interpret on curved surfaces such as wing skins.

Holography/Shearography methods require external excitation so that delaminations can be seen. This raises laser safety questions in implementation in the field, where working in enclosed areas may be difficult.

All current methods have disadvantages, particularly in implementation at the field level. None of these solutions provide rapid field identification of possible impact damage sites.

The proposed system will detect localized impact damage as small as 0.001 inches high. The system will inspect 20 square feet of surface area in 30 minutes with minimal setup time. The inspection process will be repeatable and

inspection data will be recorded to keep a history of damaged areas.

Phase I: Evaluation of the proposed inspection techniques to determine any necessary refinements or shortcomings. An evaluation of variables found on in-service aircraft surfaces and environmental conditions at typical field sites will be conducted during this phase.

Phase II: Purchase and development of equipment determined to be necessary during Phase I. Phase II will be completed by a demonstration and full implementation of a field-hardened system at a typical site.

N91-081 TITLE: Electrochemical Machining Process Optimization for Engine Components

CATEGORY: Advanced Development

OBJECTIVE: To develop a process design and optimization program for electro-chemical machining (ECM) of jet engine components. Such a design tool would allow cost-effective production of high-tolerance components for jet engine applications.

DESCRIPTION: ECM is a complex final machining operation for nickel base and titanium alloy jet engine components, such as fan and compressor blades. Optimization of the ECM process parameters for these complex parts often requires many iterations to achieve production parameters that meet the stringent tolerances required for engine applications. The trial and error route leads to increased component fabrication costs. This project will develop a process design program, using both heuristic (knowledge-based) and analytical modeling, to establish ECM process parameters from part configuration and material description.

Phase I will entail development and Phase II will apply the program to several prototype components and will establish the resulting production cost and quality payoffs.

N91-082 TITLE: UAV Propulsion System Heat Exchanger Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop the lightest, smallest, and most efficient cooling system for use on UAV diesel engines.

DESCRIPTION: Current liquid cooling systems used with unmanned aerial vehicles (UAV's) engines consist of large liquid to air heat exchangers circulating a glycol/water mixture. When integrating the cooling system into an air vehicle, there is an aerodynamic drag penalty due to the cooling radiator. Advances in size and weight reduction with an increase in efficiency would greatly benefit present and future UAV's. DOD would therefore like to investigate any new heat exchanger/cooling system concepts that are applicable to lightweight UAV engines. It is anticipated that investigation into candidate heat exchanger/cooling system concepts would be divided into two phases.

Phase I: Conceptual designs would be generated and validated through theory and analytical assessment and/or testing.

Phase II: Fabricate proof-of-concept designs and experimental verification of the approach.

N91-083 TITLE: T64 Engine Compressor Erosion Resistant Blade Coating

CATEGORY: Engineering Development

OBJECTIVE: To develop a compressor blade coating that will reduce the erosion due to ingestion of sand and other particulate matter.

DESCRIPTION: The T64 engine is used in the U.S. Navy CH-53D/E aircraft which sometimes operates in an environment where sand is ingested into the engine. In some cases, the life of the compressor blades is reduced to 1/4 of their normal life expectancy. Erosion of compressor blades results in a reduction of operating efficiency and, if severe enough, engine stalls. A blade coating is desired that will reduce the effects of blade erosion. The T64 compressor blade base material is titanium.

Phase I: Provide the technology or technologies that would best accomplish the objective. Consideration must be given to producibility, assessment of effects on fatigue life, overall effectiveness, and repairability after use. An estimate of cost per unit of the final product would be helpful.

Phase II: 1) Perform fatigue testing and test the erosion capability of the coating compared to uncoated blades. The government will provide the blades for test. 2) Provide two engine sets of coated compressor blades. The government will provide an engine/field test for final assessment.

N91-084 TITLE: S-3 Aircraft Warfare Systems Architecture

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate Warfare Architectures for the S-3 aircraft avionics system.

DESCRIPTION: Top Level Warfare Requirements (TLWRs) are currently controlling Navy acquisition decisions and warfare strategies. Warfare System Architectures need to focus on TLWRs compliance. Warfare System Architecture analysis needs to be performed for S-3 aircraft avionics system using Navy TLWRs. The Warfare Systems Architecture evaluation should include functional decomposition of the S-3 aircraft mission, develop quantitative performance evaluation algorithms for S-3 Warfare Architectures, architecture evaluation analysis to determine performance capabilities and limitations, and architecture improvements to resolve performance limitations. S-3 Warfare Systems Architecture options need to be established and related to level of compliance with TLWRs.

Phase I development will include development of quantitative performance evaluation algorithms for S-3 Warfare Architectures and preliminary evaluation analysis.

Phase II developments will include complete S-3 Warfare System Architecture analysis and establish level of compliance with TLWRs.

N91-085 TITLE: Missile Lug/Composite Material Integration

CATEGORY: Engineering Development

OBJECTIVE: Develop a design/procedure for integrating missile lugs to a cylindrical case of composite material construction (braided and filament wound). If successful, the design/procedure may be incorporated in a Navy composite rocket motor case design.

DESCRIPTION: Composite materials have been successfully applied to the construction of rocket motors. Advantages have been weight reduction, increased strength and decreased cost. Recent Navy testing has demonstrated that rocket motors of composite materials react less violently to extreme environmental hazards. However, techniques for incorporating lugs (the mechanical support for attaching the missile to the aircraft's missile launcher) have not been successfully demonstrated. This technology is required to apply composite materials to the design of state-of-the-art tactical air-launched missiles. Programs concerning both composite braiding and filament winding will be considered due to the unique nature of each method.

Phase I: Develop alternative methods of integrating missile lugs to a cylindrical body constructed of composite materials. The end product of this phase will be a technical report documenting the design/procedure alternatives.

Phase II: Demonstrate the lug integration design/procedure by designing, manufacturing and testing three sample composite cylinders. The cases will be designed to AMRAAM dimensions and maximum loads and constructed of graphite fiber composite with Kevlar outerwrap. The lug design, in the area of its missile launcher interface, will be established by the government. The contractor will be responsible for designing the lug in the missile body interface area. The tests will be conducted at a government facility. The end product of Phase II will be the contractor's final report assessing the design and detailing the production procedures.

N91-086 TITLE: Virtual Reality Technology Including True Stereo Interactive Displays for ASW Aircraft Environments

CATEGORY: Exploratory Development

OBJECTIVE: Identify state-of-the-art virtual reality three dimensional (stereo effect) interactive display technology, and develop and demonstrate a system which is potentially useful for complex data/high data rate situations aboard US Navy anti-submarine warfare (ASW) aircraft.

DESCRIPTION: Current Navy ASW display technology, including hardware, software, and man-machine interfaces (MMI), desperately needs upgrading to prevent operator overload in high data rate and complex data/high display density situations. Because of rapid improvements in all aspects of display technology, and extensive independent research on MMI's, it is difficult to assess the status of research to date. This work first will attempt to identify state-of-the-art research in display technology and MMI, both within the Department of Defense and in private industry. Virtual Reality (VR) technology (including three dimensional color displays, interactive power/data gloves, special eyeglasses (video phones), special video screens, and voice-activated display command and control), and holographic technology are only some of the techniques which should be considered.

This effort will then proceed to select those techniques which seem to have the most potential for use in Navy ASW aircraft, and demonstrate them. Emphasis will be on sensor operator applications involving high data rate broadband and chaotic signals from a single source, and on tactical use in high display density situations.

Phase I: Produce a deliverable technical report surveying the field of display and MMI technology and identifying specific concepts with the greatest potential for air ASW applications.

Phase II: An optimum subset of this technology should be defined and applied to typical high data rate signals and tactical situations. Phase II deliverables should be a demonstration and a documented prototype hardware and software package which incorporates the selected technology.

N91-087 TITLE: Service Tough Composite Panels

CATEGORY: Exploratory Development

OBJECTIVE: To develop a method of toughening laminated composite panels used on aircraft structures so as to avoid delaminations around edges and fastener holes in service.

DESCRIPTION: Current Navy aircraft with fuselage skin panels fabricated of laminated graphite/epoxy composite materials experience maintenance problems with these panels. Delaminations appear along the free edges and around bolt holes, particularly when the panels are frequently handled and removed. The problem is referred to as a lack of toughness. Modifications to the resin matrix to improve its toughness do not seem to be effective in eliminating the problem. Other concepts for improving laminate toughness have so far been found to degrade the basic strength of the laminate. Innovative approaches are needed to extend the service-testing of an actual component on a Navy aircraft.

Phase I: Investigate one or more innovative concepts for toughening composite panels against delamination under service usage conditions. Limited fabrication basic properties.

Phase II: Fabricate and service-test an actual component on a Navy aircraft.

N91-088 TITLE: Reliable Sandwich Structures

CATEGORY: Exploratory Development

OBJECTIVE: Provide efficient sandwich structures without the R&M problems of current honeycomb sandwich.

DESCRIPTION: One of the most efficient structural concepts for aircraft wing and fuselage skins is the sandwich, where inner and outer face sheets are separated by a core in order to efficiently react out-of-plans bending loads. Navy service experience, however, particularly with aluminum and nomex core sandwiches, has been that excessive maintenance is required. Some of the problems are moisture intrusion and retention, and low velocity impact damage. To date, alternative cores such as foam, balsa wood, and honeycombs of fiberglass of graphite/epoxy have not provided sufficient improvement to displace the use of aluminum and nomex. Skin/stringer concepts are currently specified for all Navy application, but it would be desirable to be able to use sandwich structure without its current drawbacks.

Phase I: Examine promising innovative alternatives from a weight, cost, producibility and suitability standpoint.

Phase II: Produce prototype components and gather service experience with them.

N91-089 TITLE: Advanced Gas Turbine Engine Operability

CATEGORY: Advanced Development

OBJECTIVE: To improve fuel and air flow for varying flight environmental changes i.e. Air Combat Maneuvering (ACM), full power excursions, and extreme off axis inlet duct airflow situations that will be experienced by high agility aircraft. If successful, fewer operational engine failures would result in fewer flight departures, longer total engine life, increased engine efficiency, enhance flight safety, and lower total costs.

DESCRIPTION: Present aircraft engines are expected to maintain proper compressor variable geometry and fuel flow under all engine operational conditions i.e., altitude, temperature, high and low power, and during numerous rapid and instantaneous power excursions experienced during ACM. The purpose of this project is to determine the feasibility and provide for hardware demonstration of a concept that, though proper fuel and air flow management, will eliminate the onset of engine compressor stalls. High agility aircraft in ACM will be highly dependent on ideally linear dynamic thrust response characteristics of their engines.

Phase I should consist of an approach and a study to meet the requirements addressed above with sufficient analytical and experimental data to demonstrate feasibility.

Phase II should use the Phase I approach to demonstrate the contractor's concept applicable to a current military engine available for government testing. Phase II should also demonstrate how the new concept could be incorporated into future engine designs.

N91-090 TITLE: Enhanced Lift Thru Dynamic Flow Manipulation

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the effects of wing sweep and camber on the development of lift dynamic oscillating wings.

DESCRIPTION: Preliminary experimental studies have indicated a significant enhancement to aerodynamic lift can be derived from the oscillation of the wing. These investigations have been conducted primarily in the two-dimensional realm. It is desired to extend this investigations into three-dimensional flow to address the application of this technology to realistic flow conditions and representative wing/control surface configurations. Parameters of interest include wing sweep and camber, extent of surface area required to be oscillated to achieve the enhanced lift, extent of angle-of-attack/sideslip range in which enhanced lift is achievable and sensitivity to unsteadiness in the freestream.

Phase I: Study outlining the approach which will be undertaken to determine the significance of the parameters (e.g., wing sweep, camber) on the development of dynamic lift. The proposed effort may be either one or both computational fluid dynamics and an experimental investigation.

Phase II: Systematically evaluate the variable parameters. An analysis of application of the best concept for dynamic lift is also desired in this phase.

N91-091 TITLE: Modeling of Rotorcraft and Ship Dynamic Interface

CATEGORY: Exploratory Development

OBJECTIVE: Development of an analytical approach and computational tool for modeling the dynamics of a rotorcraft on approach and landing onboard a ship.

DESCRIPTION: Navy rotorcraft have the unique problem of maneuvering for safe landing onboard ships which are rolling, pitching, and heaving (depending on the ship and sea-state). This two-body dynamic situation is further complicated by the aerodynamic wakes generated from the ship's deck and superstructure. Currently the Navy performs Dynamic Interface testing using fleet rotorcraft and various ships of opportunity. This is a costly approach and is severely limited by the availability of fleet assets and the weather. There is a need to perform a greater portion of Dynamic Interface evaluation in the laboratory and to rely on actual testing for verification and training.

A computer code that can simulate this environment, study the rotorcraft performance, could be used to develop the best approach paths for safe landings, provide improved simulator training for pilots, and ultimately be used in the design or acceptance testing of future Navy rotorcraft.

Phase I: Study outlining the approach which will be undertaken to develop this capability. Specific computational methodologies for modeling the dynamics of the two bodies and the associated aerodynamics must be identified, with sufficient data to demonstrate its feasibility.

Phase II: Develop the computational tool and at least one specific rotorcraft and ship interface should be simulated for comparison with full-scale data. Specific data will be made available by the Navy for the Phase II effort.

N91-092 TITLE: Integrated Hydrophone

CATEGORY: Exploratory Development

OBJECTIVE: Integrate a hydrophone, pre-amp, A/D converter, and serial interface into a small, low power unit for use in large acoustic arrays.

DESCRIPTION: Introduction and purpose: Decreasing target strengths require the use of large acoustic arrays to increase processing gain. As the number of elements grows, the array complexity becomes burdensome. If all the pieces for an individual element were integrated together in a very small volume, a very simple cable could connect the entire array, greatly reducing the cost and complexity of the array. Frequencies of interest would be in the middle audio range.

Phase I: A study would explore and compare several feasible configurations, including an integrated silicon hydrophone. Power consumption, performance and volume would be the prime considerations. An attractive solution would integrate all the components on a single silicon chip. The Phase I deliverable would be the documentation of the investigation, a plan for device fabrication and a waterproof package design suitable for use in a large array.

Phase II: Results of the Phase I study would be put into practice and one hundred prototype integrated sensors would be constructed and packaged for use in a test array. Single sensors would be tested and their performance and power consumption would be documented. Phase II deliverables would be the sensor design documentation, 100 packaged sensors, and test data.

N91-093 TITLE: Extremely High Speed Optical Crossbar Switch

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop a large array electro-optical crossbar switch for integration with massively parallel systems.

DESCRIPTION: Applications for image and graphic processing such as real time perspective scene generation with photo-realistic texture mapping requires either highly expensive special purpose hardware or more recently, reasonably priced massively parallel devices (e.g., a nanosecond transfer between processors and memories in topologies greater than 1000 nodes.

Phase I: Investigate currently existing configurations of optical switch topologies for switching a display from memory location to memory location. This will also include the study of optical computing technology including, but not limited to, Optical Supercomputing Neurocomputer (c.f. H. Szu, Naval Research Laboratory, 1988) and the Compact Iterative Optical Vector-Matrix Multiplier (c.f. L. Seiman, Ford Aerospace, 1989, Neural Networks for Defense Conference). Optical switches and computing shall be characterized according to the following: bandwidth; memory capacity (number of inter-connections); memory access speed; data transfer rate; propagation delays; resistance to noise and interference; ease and method of programmability (e.g., spacial light modulator) and adaptability; error rate; light source used; photodetector material and microstructure; lens modulation transfer function (MTF), refractive index and grinding requirements. The analyses shall include a comparison of the features of optical switching with competing linear and ring bus structures.

Phase II: Recommend and design an optical topology to support an 8x8x8 and eventually a 16x16x16 processor architecture.

N91-094 TITLE: GaAs Heterojunction Bipolar Technology Development

CATEGORY: Engineering Development

OBJECTIVE: To demonstrate the feasibility of manufacturing complementary GaAs HBT circuits.

DESCRIPTION: Advanced strategic and space systems will require extremely high speed analog functions such as A/D converters for "smart weapons". GaAs heterojunction bipolar technology (HBT) offers the possibility of high speed combined with high precision. However, power requirements for this technology are rather high. A complementary HBT approach (combined NPN and PNP transistors in a monolithic chip) would help to substantially reduce power requirements without sacrificing performance. The goal of this development is to demonstrate the feasibility of manufacturing complementary GaAs HBT circuits through process development and characterization activities. Radiation hardening to strategic and space environments should also be a significant focus in the development.

N91-095 TITLE: Laser and Light Emitting Diode (LED) Arrays for Optical Computing

CATEGORY: Exploratory Development

OBJECTIVE: To develop laser diode and light emitting diode arrays for computer applications.

DESCRIPTION: There is a need for development of laser diode and light emitting diode arrays for use in optical computing and computer interconnects. The arrays should exhibit high radiance with low threshold or drive currents to be compatible with digital or analog integrated circuits. The diodes within the array should have the capability of being individually addressed with the capability to independently vary the optical intensity of each light emitting element. The operating wavelength should be in the 850 nm spectral region.

N91-096 TITLE: Advanced Strapdown Gyros, Accelerometers and Gravity Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To explore improved sensor technology for inertial navigation and control systems.

DESCRIPTION: There is a need for improved sensor technology to measure rotation, acceleration and gravity for strapdown inertial navigation and control systems. Novel approaches incorporating magnetic, optical, and superconducting principles require investigation. Design concepts must have the potential for meeting the severe military aerospace environment while minimizing weight and volume.

Phase I will consist of a design study.

Phase II will be the proof-of-concept.

NAVAL SEA SYSTEMS COMMAND

N91-097 TITLE: Light Weight Multi-Purpose Insulation System

CATEGORY: Engineering Development

OBJECTIVE: Develop a light weight insulation material system which can be used for fire, acoustic and thermal bulkhead insulation, hot and cold pipe insulation, easy shipbuilder installation, and reduced maintenance levels.

DESCRIPTION: The target performance thresholds for this product would be: a thermal k-factor of 0.3 BTU/hr/ft^2/°F, fire insulation backface temperature should not exceed 450 °F in 1/2 hour when exposed to an ASTM-E-119 test, acoustic properties meeting MIL-I-22023 and MIL-I-23054, pre-lagged surface compatible with today's Navy paints, self-adhesive backing, and a weight one-half that of current Navy insulations. This system should be capable of replacing the majority of systems presently used on Navy vessels while meeting safety and environmental requirements.

Phase I: Demonstrate the feasibility of a multi-purpose insulation system which can be used as a fire, acoustic or thermal insulation. Determine the extent of use for a Navy vessel. Develop small bench scale samples.

Phase II: Manufacture, test and evaluate the performance of the material in several typical Navy applications. Develop manufacturing process and necessary documentation to insure production.

N91-098 TITLE: Revision of Aircraft Carrier Weight, Vertical Center, and Space Algorithms

CATEGORY: Engineering Development

OBJECTIVE: Bring the estimation of weights, centers and required areas in the aircraft carrier synthesis model up to date.

DESCRIPTION: Phase I: Develop algorithms for estimating weight, vertical centers and required areas that generally depend on gross ship attributes available at the earliest stages of design. The algorithms should reflect the changes in standards and practices since the current algorithms were developed from historical data.

N91-099 TITLE: Feasibility Study of Scaled Surface Ship Model for UNDEX Experiment

CATEGORY: Engineering Development

OBJECTIVE: To develop and verify methodologies for resolving the following issues critical to the design and verification of ships resistant to the effects of underwater explosions: (1) scaling laws; (2) the physics of surface and bottom effects, bulk cavitation, gravity, and time; (3) feasibility of devising pressurized tank, centrifugal machines or any innovative ways to solve the problems; (4) model complexity for ideal representation of true ship characteristics; and, (5) limitations and validity of testing scaled models of ship sections.

DESCRIPTION: The Naval Sea Systems Command currently conducts full-scale at-sea underwater explosion shock trials against representative ships of the class. Trials such as these are necessary to verify that the ship is properly designed and built to withstand the effects of enemy weapons in a combat environment. It is desired to be more able to use the results of trials such as these to modify ships under design and/or construction to improve their survivability. Unfortunately these trials are by their

very nature not able to be conducted until after the lead ship of the class is delivered to the fleet. It is the objective of this task to provide the capability to use scale models of ships or ship sections to verify the ability of a ship to survive underwater explosion shock prior to the construction of a completed ship. This would result in both increased fleet survivability and reduced overall program costs.

Phase I: Conduct a review of the existing material on scaling laws for model testing and determine the applicability of these laws to the environment developed by underwater detonations of high explosives.

Phase II: Based upon the physics of underwater detonations and the other concerns as noted above devise improved/automated scaling laws that could be used by ship designers/analysts to predict the survivability of critical structure, systems, or equipment based upon model testing prior to the construction of the actual ship.

N91-100 TITLE: Assessment of Reliability of Ship Structures

CATEGORY: Engineering Development

OBJECTIVE: Derive the reliability levels associated with important failure modes of ship structures, and their sensitivity to variations in materials, design criteria, and loading conditions. This is necessary for the determination of the risks associated with an aging fleet. In addition, it will provide a baseline and methodology for more reliable design of future ships, both of conventional and advanced hullforms.

DESCRIPTION: Phase I: Perform an assessment of reliability levels of several ship types selected on a basis of operational requirements, size, etc., by:

- o Select ship types (a minimum of three different types)
- o Collect all statistical data on loads, stresses, materials and strengths necessary for reliability assessment calculations.
- o Perform a sensitivity analysis of the ship to variations in materials, design criteria, and loading conditions.
- o Perform a literature search on methods of risk assessment of ship structures.
- o Define critical hull girder failure modes

Phase II: If Phase II is authorized:

- o Evaluate computer codes suitable for ship reliability.
- o Complete collection of statistical data on loads, stresses, strengths necessary for reliability assessments.
- o Complete sensitivity analysis of the ship to variations in reliability parameters. Redefine critical failure modes for structural reliability.
- o Perform analysis and estimate failure probabilities for each failure mode.
- o Document the probability of failure estimates for the selected ships, and their sensitivity to variations in selected design parameters.
- o Recommend minimum acceptable reliability levels for each ship type, and failure mode.
- o Recommend improvements to structural reliability that have the highest payoffs.
- o Provide guidelines for ship structural designers on acceptable risks associated with different failure modes, so that future structures would be designed to uniform reliability levels based on ship requirements and characteristics, and so that unconservative or over designed ship structures will be avoided.

N91-101 TITLE: Refrigeration System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype refrigeration system for potential shipboard use.

DESCRIPTION: Phase I: Concepts may use Stirling, Brayton cycle, thermal electric, vapor compression, etc. If a vapor is used it must be a non-ozone depleting substance. Target size is 1 to 15 tons of refrigeration at minus 10 degrees F while using sea water at 88 degrees F as the heat rejection reservoir. Prototypes should be designed for 1 ton capacity. Innovative approaches are invited. Size, weight, power consumption, reliability, and safety are critical parameters.

Phase II: Prototype systems shall demonstrate performance at rated conditions and operation at part load conditions. The system design shall minimize vapor leakage while being easy to maintain.

N91-102 TITLE: Fiber Optic Navigation Light System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a fiber optic navigation light system that will meet the 72 COLREGS and optical requirements of UL-1104, and achieve the following:

(a) Be immune to EMI/EMP problems.
(b) Minimize topside weight high on masts.
(c) Eliminate the need for bulky shielding.
(d) Increase safety by eliminating the need for climbing masts to relamp fixtures.

DESCRIPTION: Phase I: Determine the feasibility of a fiber optic navigation light system (using commercially available fiber optic cable to transmit light to the fiber optic navigation light fixture) complying with the 72 COLREGS and optical requirements of UL-1104.

Phase II: Develop and construct a breadboard model for testing.

N91-103 TITLE: Electromagnetic Arrays for the Next Generation Ships

CATEGORY: Advanced Development

OBJECTIVE: To develop an architecture to guide the evolution of the next generation electromagnetic arrays for warships.

DESCRIPTION: Both government and industry are developing a/d converter, processor, and transmitter/receiver elements, in a fragmented way. Most of their goals, have been towards producing elements, for replacement of, or changes to, today's systems. The next generation of shipboard systems will need to integrate the functions of communications, radars, electromagnetic identification, electromagnetic countermeasures, and navigation into integrated electromagnetic arrays. The arrays will need to cover the electromagnetic spectrum. They will need to be installed, throughout the outside structure of the ships. This approach will have the advantages of more survivability, lower radar cross section, modularity for growth in capabilities, lower volume, and greater power efficiency, than current alternatives. Through these study efforts, the Navy can provide focus and leadership on the integrated architecture, and the electromagnetic elements required.

Phase I: The first phase would be an industry/government survey, for the best architectural concepts for an integrated shipboard system.

Phase II: The second phase would develop an optimum set of specifications, with the cooperation of both government and industry. The project would then transition into a demonstration phase, with two frequency bands. The demonstration would show the feasibility of covering the spectrum, in a full scale 6.4 engineering development project.

N91-104 TITLE: Reformulation/Reuse of Navy Gun Propellant

CATEGORY: Exploratory Development

OBJECTIVE: To establish a use/market for single, double and triple base propellant reclaimed from Navy propelling charges.

DESCRIPTION: Phase I: Conduct literature search into available technology to reuse/reformulate single, double, and triple base propellant reclaimed from Navy propelling charges. Investigate past commercial sales and determine ultimate use of propellant. Explore potential uses of material as removed from the cartridge cases and by reformulation. Verify that information in literature supports continued stability of nitrocellulose and nitrocellulose/nitroglycerine based propellants if reused and proposed reformulation technology presents no safety problems. Provide recommendations for Phase II evaluations.

Phase II: Perform laboratory, bench and pilot scale testing for reformulation of the propellant. Perform evaluations to validate reclaimed propellant that can best meet specification requirements and performance criteria for reuse for either military or commercial applications. Perform complete systems safety evaluations to confirm no problem exists in removal and reuse of the nitrocellulose and the nitrocellulose/nitroglycerine based propellants.

N91-105 TITLE: Software Engineering Methods for Parallel Processing Arrays

CATEGORY: Exploratory Development

OBJECTIVE: To formulate a methodological approach to the problem of taking an application from concept to a validated, optimal mapping onto an appropriate array of parallel processors.

DESCRIPTION: A customer (user) with a problem to be solved on a parallel computing system is met with a bewildering number of choices to make. There are dozens of architectures to choose from, with many available in commercial systems,

boards, chip sets, and single-chip systems, with wafer-scale systems coming. Each of these is capable of implementing from one to many processing models. Examples include: SIMD, synchronous, data parallel; MIMD, synchronous or asynchronous, data-flow or control-flow, process- or application-parallel, etc. The user's problem can contain different parallelism. Merely capturing the specification of the application algorithm, which involves selecting an appropriate language, presents hundreds of choices. The user has requirements beyond the algorithmic: throughput, memory usage, result precision, latency, weight, power, size, cost, (NRE, life cycle). The usual reaction to this plethora of choices is to select a hardware solution supported by a friendly vendor, and thereby reduce the solution space dramatically. This is effective, if not optimal, but locks the user into a system that will probably not meet all of his requirements, and will not evolve with technology. The better solution would be a methodology, well supported by expert systems and tools, all of which are maintained current with technology, which can assist the user in finding an optimal mapping of his problem onto a parallel processing system which meets all of his requirements as well as possible. This methodology would support: problem and requirements capture by alternative methods appropriate to the problem/segment, with expert system guidance; reduction of the application to a standard intermediate form; (guided) selection of choices of alternative architectural and execution models to be examined in trades; performance analysis of the application on the chosen models through simulation or emulation; representation of the final solution in a language appropriate to the selected target system; validation of the solution as implemented on the target. This methodology would draw for its parts, as possible, on the broad base of academic, government, and industrial research and development. Added value would come from a systematic process, development of a formal basis for the methodology, the integration of usable products, and the development of new tools as required.

Phase I: Survey the literature and technology to ensure currency. Focus on a particular parallel architecture which represents the most likely future direction for implementation in VLSI and WSI. Describe the taxonomy of problem- and solution-spaces. Formulate the methodology which systematically moves from problem description to validated solution, application capture, analysis, mapping, execution, and validation. Define tools and adjunct methods, such as graphical user interfaces, databases, and AI techniques, needed to support the methodology.

Phase II: Update the literature and technology survey (annually). Refine the methodology. Acquire and/or implement prototype tools to demonstrate the methodology; distribute to Alpha users and introduce modifications based on experience.

Phase III: Produce Beta versions of the tools, distribute to testers, and incorporate experience. Produce commercial production grade tools, distribute and support.

N91-106 TITLE: Providing Full ADA Support for the UYS-2

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate the feasibility of automatically generating a complete and easily validated Ada compiler for any configuration of the AN/UYS-2.

DESCRIPTION: The UYS-2 is a system that embodies the concepts associated with dynamically distributed parallel processing. It was designed to particularly address signal processing applications which inherently contain opportunities to improve mission performance through the use of this type of processing The UYS-2 System includes "compute processors' that are functional elements intended to efficiently execute compute intensive application programs. One such processor is the Floating Point Arithmetic Processor; a second will be the Matrix Processor. Plans call for additional computer processors, optimized to specific applications or classes of applications.

A particular configuration of the UYS-2 is tailored to a mission problem. This is partially accomplished by including one or more compute processors, of one or more varieties. That is, for example, a particular configuration might have two FP Arithmetic Processors and three Matrix Processors, because the parallel processing characteristics of the mission problem being addressed and the compute requirement of the mission both need, and can effectively use, these hardware resources. These may be placed into a variety of backplane slots.

The UYS-2 System also includes some rather sophisticated programming tools built around the Processing Graph Methodology (PGM) which enable the design of an application system to be done at a high level, expressed in graph notation, and then, mostly automatically, be translated into code strings that are executable within the various functional elements of the UYS-2. However, when one examines the hardware and software design that underlies the PGM level, one finds a structure that is basically designed to support and facilitate hand microcoding.

To support a compute processor, such as an FPAP, in the UYS-2, one must develop in hand crafted microcode a set of EMSP Primitives appropriate to support the intended applications on the machine. This is not an instruction set, as one might associate with a conventional Instruction Set Architecture machine, that remains fixed once designed; it changes, at least by extension, for each type of application of interest. When the library of EMSP Primitives (i.e., microcode macros) are developed and in place, then the process of converting PGM graphs to executable code is efficient and mostly automated. For

each compute processor that one wishes to incorporat‹ into the UYS-2, one must develop microcode similar to the set needed for the FPAP.

There are several problems with this software development methodology as follows: incorporating a new compute processor into the UYS-2 requires the development of an extensive set of microcode.

Extending the set of applications to which the UYS-2 is to be applied, and which require the support of new PGM level primitive nodes, will in general require additional microcode macros to be developed to achieve throughput objectives.

Unless the set of EMSP Primitives and the I/O operations are equivalent from one compute processor to another, the programs will be different on each process or for the same graph level primitive node. No portability from processor to processor is likely; even if portability is intended and planned, it will be very difficult and costly to verify and control.

Each new compute processor incorporated into the UYS-2 requires the development of a relatively large and complex software development support environment, including microassemblers, linkers, simulators, and debugging tools.

5. The UYS-2 system does not take advantage of high level programming languages, particularly Ada, to solve problems of software reusability, rapid development of application systems, and life cycle cost reduction. Further, UYS-2 compute processors (i.e. the FPAP) do not facilitate the use of high level languages; rather, they are designed to meet the need of the hand microcoder to partition the implementation problem into small segments in order for him to understand and be able to cope with the problem. This general partitioning strategy can lead to quite good results on a segment by segment basis, but is often very poor on a global basis. Compilers generally do a better job on large compute problems than do handcoders, due mainly to their ability to evaluate many more opportunities per unit time than the person can and their indifference to the size of the problem being addressed.

In summary, the UYS-2 problem of interest herein is to provide software tools that utilize Ada while maintaining the inherent advantages of the present programming environment, and thus gain the advantages inherent in the language, and also greatly reduce the time and cost involved in addressing both new processing elements and new applications.

The proposed solution involves the application of the JRS Integrated Design Automation System (IDAS) to provide the Ada to Microcode Compiler and Software Development Tools needed to support current and future compute processors. One of the primary functional capabilities of IDAS is the ability to automatically generate an Ada Compiler and a Simulator for an arbitrary processor described in the VHSIC Hardware Description Language (VHDL). Using this capability, one could then automatically create the tools with which to evaluate and support the target processor directly from the normal design documentation. Thus, the UYS-2 development tools are all contained within one common environment for all of the processor types. The application code will then be portable in Ada source code form and maintainable, therefore, in Ada, for all the processors.

Another major consideration in introducing Ada into the USY-2 is that it makes the connection between the PGM Graphs and the executable code in the compute processors much more natural, direct, and maintainable. The Primitive Graph Nodes already have Ada program representations of their functionality, developed for the PGSE system.

Phase I: The first phase will be a system design and planning activity that would result in detailed specifications, design guidelines, and development plans.

Phase II: Develop the Ada integrated UYS-2 environment.

Phase III: Demonstrate an Ada compiler produced for an arbitrary AN/UYS-2 configuration, and show that it will pass the Ada Validation Suite.

N91-107 TITLE: Rapid Prototyping and Simulation with Programmable Gate Arrays

CATEGORY: Exploratory development

OBJECTIVE: To demonstrate the feasibility of rapidly determining whether or not a processor design is suitable, from a performance perspective, for its intended application(s). Related to this is the demonstration of the feasibility of rapidly constructing an operational piece of hardware that implements the functionality of the processor of interest, that performs adequately from a real time perspective, and that can be electrically connected to other hardware elements with which the processor is operationally integrated. In short, it is the problem of rapidly constructing a physically realized hardware prototype.

DESCRIPTION: Programmable gate arrays are a component technology that is potentially very useful in solving rapid prototyping problems. The technology provides a programmable hardware element that could be made to represent essentially any arbitrarily complex digital circuit. The individual gate array circuits are VLSI devices and contain several thousand gates each, organized into hundreds of configurable logic blocks. It is a very flexible, potentially useful technology.

Recent activities towards the exploitation of this technology have focused on the problem of providing "arrays of programmable gate arrays"; that is, the focus is on the problem of interconnecting the gate arrays in networks, so that one could map very large digital circuits onto the network. This will eliminate the fairly severe limitations on the utility of the technology, when applied one device at a time, and open the doors to the possibility of processor rapid prototyping.

The proposed solution to the processor rapid prototyping problem brings together two technologies in an eminently synergistic manner. The first is the programmable Gate Array (PGA) circuit technology, the second is the JRS Integrated Design Automation System (IDAS) technology.

PGA technology is being pursued by constructing large arrays of the devices, that will provide between 500,000 and 1,000,000 equivalent gates or 10,000 to 20,000 configurable logic blocks, that can be automatically configured to represent complex processors. This size array can be packaged onto one VME size board that plugs directly into the backplane of an appropriate host (e.g., SUN). The PGA board can then be driven by the host processor; it can be configured by it; it can receive static or dynamic input data from it; and, it can return output data to it, statically or dynamically. The host processor provides the environment for testing a prototype, fcr doing an evaluation of its suitability or comparative effectiveness.

The PGA board becomes a hardware simulator/emulator of the target processor; it provides the test bed for testing and evaluating alternatives. The PGA board can then be the actual physical hardware prototype or the configuration data can be transferred to other physical manifestations that might be more useful in a particular system environment.

IDAS technology provides the processor synthesis tools and the links to designers working in VHDL that are necessary to effectively utilize the potential of the PGA board in a significant manner.

Processor synthesis in IDAS creates processor representations that are implemented in components contained in libraries and are expressible in VHDL. The VHDL description is then processed to generate a software simulator for the implemented processor.

One will then be able to use IDAS to synthesize application specific processors, simulate and evaluate them very fast on the VGA Board, and return results to designers. The configured PGA Board, or a translated image of it, could also be used as a physical prototype for actual interconnection to other hardware such as the backplane of the AN/UYS-2.

Phase I: Construct 500,000 to 1,000,000 equivalent gates array packaged onto one VME size board that plugs directly into the backplane of an appropriate host (e. g. SUN). Configure and produce software on the host processor to provide the environment for testing a prototype, for doing an evaluation of its suitability or comparative effectiveness

Phase II: Utilize the IDAS technology to provide the processor synthesis tools and the links to designers working in VHDL that are necessary to effectively utilize the potential of the PGA board in a significant manner.

Phase III: Produce commercial production grade tools, distribute and support.

N91-108 TITLE: Electro-optical Horizon Tracker

CATEGORY: Exploratory Development

OBJECTIVE: A reliable means to locate and track the optical horizon using infrared sensors is required.

DESCRIPTION: Determination of this horizon using current techniques poses a difficulty. A means to locate and track this horizon to micro-radian accuracy is desired. This will increase the overall performance to detect and track targets for regions of military interest.

Phase I: Perform an industry survey of current and emerging horizon tracking techniques. Identify potential candidates. Construct a plan of action.

Phase II: Write a specification. Fabricate a breadboard to demonstrate the desired capability. Write a test report with recommendations. A Phase III potential for AN/SAR-8 IRST exists.

N91-109 TITLE: Hypervelocity 25mm Projectile

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to assess the feasibility of obtaining a Hypervelocity round through a "Tround," Cased Telescoped, Compacted Propellant configuration. Investment in Tround, Case Telescoped Round and Compacted Propellant Concepts have resulted in proving that there are viable benefits to be gained from Tround and Case Telescoped Round configuration. Practical application of each concept has successfully completed the demonstration phase.

DESCRIPTION: Phase I: Analyze the viability of combining the developed concepts and assess whether benefits can be derived through this synthesis. Elements of interest would encompass Kinetic energy projections, effects relative to obturation, round ballistics, to mention a few. Comparative analysis of Tround versus Case Telescoped Tround and similar analysis of compacted versus conventional propellant in Case Telescoped application is within the scope of this task

Phase II: Design, develop, fabricate and conduct test and evaluation on prototype round configuration. Demonstrate and measure experimentally obtained and/or projected results of the assessment provided in Phase I. Based on results, if proof of benefits are observed, project viability of larger calibre application.

N91-110 TITLE: Highly Sensitive Fiber Optic Acoustic Point Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop highly sensitive point sensors that can be used to construct high gain volumetric arrays for short range high resolution or long range low resolution sonar.

DESCRIPTION: Phase I: Develop several highly sensitive point sensors each having a laser light source and a pair of light reflecting thin films arranged to form a Fabry-Pe' rot resonator. Additionally, develop demodulation electronics capable of detecting changes in acoustic fields by measuring the movement between the optical films.

Phase II: Develop a densely packed volumetric acoustic array test panel with 500 point sensors that will survive the maximum hydrostatic operating pressure experienced by a government furnished unmanned under-water vehicle (UWV).

N91-111 TITLE: Advanced Anti-Submarine Warfare Data Fusion Algorithm

CATEGORY: Exploratory Development

OBJECTIVE: Develop data fusion methods and algorithms for improved targeting of contacts for utilization in underwater combat control systems.

DESCRIPTION: Phase I: Develop non-linear, discrete tracker algorithms capable of fusing positive (detection) and negative (no detection) information from multiple sensors and platforms to provide estimates of target location in terms of probability distributions.

Phase II: Provide computer based system that can be tested at sea under realistic environments. System shall interface with multiple sensors (sonobuoys), and towed arrays from submarines and surface ships.

N91-112 TITLE: Unity Power Factor Power Supplies

CATEGORY: Advanced Development

OBJECTIVE: Current harmonics in linear rectifiers are often in excess of 10% of the fundamental. Polyphase transformers can be used to achieve current harmonics of less than 3% of the fundamental, but are heavy and large.

DESCRIPTION: Develop a three-phase, unity power factor power supply, that utilizes semiconductor components in lieu of polyphase transformers, to limit current harmonics to 3% while maintaining the isolation characteristics inherent in transformers. Upon completion of Phase I development, this project will transition to Phase II development.Phase I: Identification of alternative methods for achieving unity power factor rectification, bench top testing and trade-off analysis of different approaches to be used for transition to Phase II development.

Phase II: Development of a lOkw demonstration unit that meets the electrical requirements of MIL-STD-l399, Section 300 and the high impact shock requirements specified in MIL-S-90l. The nominal line voltage input to this unit will be 440V, 60Hz. The nominal output voltage will be 155V dc, as specified for Navy Standard Power Supplies in NAVSEA SE-010-AA-SPN-010.

N91-113 TITLE: Remote Transfer of Optical Data

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to reduce the weight of above deck optical equipment to allow higher mounting with resultant increased system coverage and range. It has potential Phase III application to following generations of Infrared Search and Target Designation systems, such as AN/SAR-8.

DESCRIPTION: Phase I: Industry survey of existing and emerging technology and materials. Identify likely candidates. Develop a technical plan of action.

Phase II: Write a system specification and fabricate a breadboard device to assess the adequacy of the technical approach. Write a test report with recommendations.

N91-114 TITLE: Comparison of DOD Electromagnetic Interference (EMI) Specs to Commercial Specs in Order to Aid the Procurement of Non-Developmental Items (NDI)

CATEGORY: Advanced Development

OBJECTIVE: Compare current DoD EMI specs to current and near future EMI control specs and standards in order to facilitate the procurement of NDI.

DESCRIPTION: Phase I: Establish the relationship between DoD EMI specifications and standards and commercial/industrial standards. NDI, with current certification through a non-DoD authority (e.g. FCC, VDE, Etc.), can be procured with the restrictions developed under this effort.

Phase II: Develop an Expert System (rule based) database in order to aid the procuring activity responsible for EMI associated with NDI. This system will be IBM PC compatible.

N91-115 TITLE: Commercial Computer Ruggedization

CATEGORY: Advanced Development

OBJECTIVE: Provide a concept of ruggedized commercial computer technology that will withstand Marine Environment and Operations.

DESCRIPTION: Phase I: Develop the concept and provide an approach that will allow ruggedized computers to be utilized in critical systems at sea, operating under wartime conditions.

Phase II: Provide the breadboard, and test to MIL-STD-461, MIL-E-16400, MIL-STD-1399, and MIL-S-901 to determine acceptability of the concept and provide complete unit for NAVSEA testing.

N91-116 TITLE: Electromechanical Circuit Breaker Designs

CATEGORY: Engineering Development

OBJECTIVE: Develop an electromechanical equipment type circuit breaker that will withstand high impact shock, as specified in MIL-S-90. At the completion of Phase I development, this project will transition to Phase II development.

DESCRIPTION: Phase I: Conduct exploratory development of shock hardened circuit breaker concepts that will withstand high impact shock. Concepts for shock hardening would be used for design guidance during Phase II development to build a prototype circuit breaker.

Phase II: Demonstrate prototypes for an equipment sized, shock hardened electromechanical circuit breaker that meets the high impact shock requirements of MIL-S-901. This circuit breaker will be used to replace circuit breakers manufactured in accordance with MIL-C-55629 and will be designed accordingly. The required capabilities are as follows:

Shock - as specified in MIL-S-901
Voltage - 250V 60Hz, 155V dc
Current - 0.5A to 50A
Time/current condition - 125% overload in 25 seconds
150% overload in 1 second
200% overload in 0.1 second
Size - 2.5" x 3" x 3" for a 3-phase unit

N91-117 TITLE: Solid State Circuit Breaker

CATEGORY: Exploratory Development

OBJECTIVE: Develop a nonlinear conduction material and circuit breaker that exhibits low impedance characteristics when under nominal current conditions, and high impedance under fault current conditions.

DESCRIPTION: This device will operate as a conventional circuit breaker, i.e. be able to turn-on, turn-off (with minimal leakage current) and trip given a time/current condition. Also, this device will limit fault current. At completion of the Phase I development this program will transition to Phase II development.

Phase I: The nonlinear conduction material that exhibits low impedance at low current and high impedance at high current would be developed during this stage. This material will be strong enough to withstand high-impact shock as specified in MIL-S-901.

Phase II: The nonlinear conduction material will be integrated into a circuit breaker architecture during this phase. The abilities to turn-on, turn-off with minimal leakage current, and to trip given a time/current condition will be demonstrated. This circuit breaker will be used to replace circuit breakers manufactured in accordance with MIL-C-55629 and will be designed accordingly. The required capabilities are as follows:

Shock - as specified in MIL-S-901
Voltage - 250V 60Hz, 155V dc
Current - 0.5A to 50A
Leakage current - 5mA
Time/Current condition - 125% overload in 25 seconds
150% overload in 1 second
200% overload in 0.1 second
Current limit - 10 times rated current
Size - 2.5" x 3" x 3" for a 3-phase unit

N91-118 TITLE: Mission Readiness Reporting System

CATEGORY: Advanced Development

OBJECTIVE: The objective of this task is to provide a design concept of the Mission Readiness Reporting System (MRRS). The MRRS is a system that collects, processes, and displays status information from ship equipment to determine the readiness level of major warfare areas. The design will include the following parameters:

- o What is the format, content, and timing of status data sent from equipment?
- o How does the MRRS collect status data from equipment?
- o What type of communication architecture does the MRRS use to distribute readiness information?
- o How and where is status information displayed?

Upon completion of Phase I development, the program will transition into Phase II development.

DESCRIPTION: Phase I: Investigate and define the required status data from equipment including format, content, and timing

- o Define an interface by which equipment transmit their status information to the MRRS.
- o Investigate and define a communication architecture for the MRRS to collect and distribute status information.
- o Investigate and select a display suitable for use in the MRRS.

Phase II: Assemble, test, and demonstrate a MRRS prototype for proof of feasibility. The prototype setup includes simulation inputs/outputs, partial communication network or data link, displays, and computer programs.

N91-119 TITLE: Fiber Optic LAN Based Integrated Shipboard IC System

CATEGORY: Engineering Development

OBJECTIVE: Demonstrate feasibility of implementing an integrated shipboard interior communication system, using a fiber optic LAN as a transmission medium, that will support both voice and data transmission.

DESCRIPTION: Phase I: Develop a top level architecture for a fiber optic LAN based shipboard interior communication system that has the following attributes: a) based on open architecture: b) uses military and or commercial standards: c) is survivable d) is modular (can be adapted to various size vessels); 3) provides both administrative and tactical services; f) provides integration path for voice and data.

Phase II: Based on Phase I architecture, build a prototype system that demonstrates all attributes.

N91-120 TITLE: Remote Personnel Monitoring System

CATEGORY: Engineering Development

OBJECTIVE: Develop a monitoring system that would provide status (condition and position) of shipboard personnel to a command/control station. Personal monitor would have to be small and light weight. System would have to be able to operate in the shipboard battle damage environment.

DESCRIPTION: Phase I: Investigate, develop, and design a Remote Personnel Monitoring System for naval vessels. Deliverables would include copies of all investigations, feasibility studies, design drawings and cost estimates.

Phase II: Build and test a limited scale prototype system. Size of system should be sufficient to demonstrate that all Navy requirements can be met.

N91-121 TITLE: Application of High Speed Gas Chromatography to Shipboard Magazine Sensors

CATEGORY: Engineering Development

OBJECTIVE: Develop a sensor that would provide advance warning of deteriorating or hazardous conditions in shipboard magazines.

DESCRIPTION: Phase I: Investigate the possibilities of applying high speed gas chromatography techniques to permanently mounted shipboard magazine sensors capable of detecting and providing advance warning of the following conditions:

-torpedo or missile liquid fuel leaks
-deteriorating solid fuel propellants
-deteriorating explosives and powders
-early detection of fires

This phase would include providing cost estimates for such a system.

Phase II: Build and test a prototype sensor capable of meeting all shipboard requirements.

N91-122 TITLE: Methods of Expressing Interface Design Standards (IDS) and Protocols

CATEGORY: Advanced Development

OBJECTIVE: Investigate methods for expressing IDS/protocols in such a manner that they cannot be misinterpreted

DESCRIPTION: Phase I: Shall consist of investigating whether cost effective and feasible methods for expressing an IDS/Protocol in a clear and concise manner (i.e mathematical or scientific expressions) exists.

Phase II: Would consist of translating or developing an IDS (Protocol) using the methodology from Phase I efforts. Comparison of a side by side implementation of the clear (Phase I) expressed IDS Protocol and a standard version would be a proof of concept. The Measure of Effectiveness would be the delta between the implementation and validation times of the two versions.

N91-123 TITLE: Minefield Planner Workstation Software

CATEGORY: Advanced Development

OBJECTIVE: Apply operational observables to software for a minefield planning workstation which will transition in Phase III to the CAPTOR Improvement line (PE 0603601N-S2024).

DESCRIPTION: Phase I: Perform research to determine how observations of transits by mine countermeasure (MCM) vessels or other non-target traffic through a minefield impact MCM tactics and how this information can be applied to designing mines and planning minefields. The results of this research will be incorporated into a software package that can be used to plan or design a minefield to remain effective for a specified length of time.

Phase II: Incorporate the Phase I software package into prototype workstation software for planning and evaluating countered minefields. The resulting workstation software must accommodate scenarios including up to 200 transits of non-target vessels at each of five or more minefield target places. This software must also incorporate such concepts as: ship counters, multiple target place configurations, and multiple-class multiple-signature target traffic. During the second portion of

Phase II, additional software will be developed for planning MCM operations and will incorporate all the aforementioned capabilities of the minefield planning software. All of the workstation software must allow installation and operation in desktop PC compatible computers using only commercially available co-processors and within commercially available memory and storage limits.

N91-124 TITLE: ASW Search Planning

CATEGORY: Advanced Development

OBJECTIVE: Develop rapid techniques for optimizing ASW system lineup and search plans based on real time tactical information. This capability is required to support the APP Program and the ASW Tactical Decision Aid. Acoustic performance prediction programs have traditionally modeled sonar system performance providing insight to tactical decision makers for optimizing system lineup and search plans prior to arriving on station. Parallel processing computers and neural networks offer the potential for using real time tactical information and generating revised recommendations. Improving the trade-off between run time and accuracy for existing APP applications may also be possible.

DESCRIPTION: Phase I: It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates feasibility of technique.

Phase II: Provide a computer-based system which could be tested at-sea under realistic conditions.

N91-125 TITLE: Sensor Data Correlation/Classification

CATEGORY: Advanced Development

OBJECTIVE: Provide an approach to heuristically correlate sonar, ESM, visual, and other sensor data to provide classification and threat assessment. This is needed to support the ASW Tactical Decision Aid and various combat control systems. Assessing the threat to own-ship in a multi-target environment is a complex problem that requires the ship or submarine commander to analyze the enemy sensors and weapons that can be employed. The first step in that process is developing a picture of enemy forces present in the area based on own-ship sensor data and various intelligence sources. A tactical decision aid that heuristically correlates sonar, ESM, visual, and other sensor data and provides classification and threat assessments would greatly ease the burden on the ship/submarine commander.

DESCRIPTION: Phase I: It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates feasibility of technique.

Phase II: Provide a computer-based system which could be tested at-sea under realistic conditions.

N91-126 TITLE: Advanced Targeting Algorithms

CATEGORY: Advanced Development

OBJECTIVE: Develop the methodology/algorithms to aid in the tracking/targeting process on a long-range passive contact. These algorithms are needed for the SFMPL, ASW Tactical Decision Aid, and various combat control systems. The current methodology of employing JASA/MPKAST/MTST algorithms have limitations. A novel approach is needed which would extend their methodology toward a common algorithm/approach or devise a new methodology.

DESCRIPTION: Phase I: It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates feasibility of technique using synthetic data.

Phase II: Provide a computer-based system which could be tested at-sea under realistic conditions.

N91-127 TITLE: Acoustic Towed Array Motion

CATEGORY: Exploratory Development

OBJECTIVE: Towed acoustic arrays have motions that can cause acoustic contacts that appear to "wander" when actually the array is "wandering". If the array motion is known then the actual behavior of the acoustic contact can be calculated. The Navy desires a method to calculate actual acoustic motion by calculating array motion. The Phase I proposal will develop an approach based on a hypothetical array of 100 feet in length, a single heading and depth sensor, and consisting of 20 hydrophones. The offeror must demonstrate an in depth knowledge of towed array motion and acoustic processing.

DESCRIPTION: Phase I: The results of Phase I are a computer based simulation of sensor position based upon sensor motion and a comparison with known motion.

Phase II: If Phase I shows the array motions can be correctly calculated, Phase II would demonstrate the technique at sea with an actual array in a Navy supplied test bed.

N91-128 TITLE: Torpedo Acoustic Processing

CATEGORY: Exploratory Development

OBJECTIVE: Torpedo signatures differ significantly from surface ship and submarine signatures. Most of the effort in detecting and tracking acoustic contacts has concentrated on other than torpedo signatures. An acoustic detection and tracking system is desired that is specifically tailored to the torpedo characteristics. The offeror must demonstrate experience in both acoustic signal processing and torpedo acoustic characteristics and possess a SECRET clearance.

DESCRIPTION: Phase I: Demonstrate the process in a laboratory based system with a limited acoustic data set provided by the Navy.

Phase II: Integrate this system into a Navy test system for laboratory and at sea testing.

N91-129 TITLE: Active Noise Cancellation

CATEGORY: Exploratory Development

OBJECTIVE: Shipborne noise is coupled into hull mounted sonar sensors through the mechanical mounting. Traditionally this noise is reduced with damping material and isolation mounts. Recent advances in noise control have used active methods for noise cancellation.

DESCRIPTION: A method is desired that would replace the passive mounting fixtures with active mounts. This method must demonstrate superior noise control when compared with or coupled with the passive isolation system. The offeror must possess expertise in active noise cancellation and should demonstrate an understanding of the noise mechanisms associated with sonar arrays.

Phase I: Demonstrate the technique in a laboratory environment.

Phase II: Demonstrate the technique at sea in a Navy supplied test ship.

N91-130 TITLE: Acoustic Dynamic Range

CATEGORY: Exploratory Development

OBJECTIVE: The dynamic range of current acoustic sensor systems make it impossible to detect small signals in the presence of large signals. Dynamic range is specified in dB or number of significant bits. A processing system is desired that has a minimum of 20 bits dynamic range and a minimum frequency range of 0-2000Hz; larger ranges are desired if possible. The system will be used for sonar signal processing. The offeror must possess expertise in acoustic signal processing, sonar characteristics, and be knowledgeable in what limits the dynamic range of a system.

DESCRIPTION: Phase I: Fabricate an acoustic channel that would digitize the acoustic output of a hydrophone. This system would be tested in an acoustic tank to measure dynamic range. The Navy will provide the test facilities if not available at the contractor's facility. It is important that the basic sensitivity of the system not be above the ambient level of sea state zero.

Phase II: If Phase II is authorized, fabricate a system to be demonstrated at sea in a Navy test bed.

N91-131 TITLE: Passive Torpedo Detection/Classification Algorithm Development

CATEGORY: Advanced Development

OBJECTIVE: To develop, implement and test an optimum or near optimum algorithm for the automatic detection/classification of all current torpedoes by means of their related noise.

DESCRIPTION: Phase I: Evaluate current techniques for automatic detection/classification of passive torpedoes. Identify nes signature driven processing requirements resulting from weapon propulsion plant evolution. Develop realistic models of submarine self noise backgrounds. Implement software realizations of proposed processing schemes for detection/classification. GFI weapon and self noise data will be required.

Phase II: Exercise the software processing implementations against recorded submarine self noise data to determine false alarm rate and against recorded weapon/classification. The final composite processing algorithm will be tested at sea against a variety of weapon types.

Phase III: Transition of this effort should provide an input to the new sonar intercept program (NSIS). In this context detection/classification is intended to denote detection of torpedoes as a class (ie: rejection of non-torpedoes) and does not imply classification as to type.

N91-132 TITLE: Application of Expert Systems in Submarine Combat Systems

CATEGORY: Exploratory Development

OBJECTIVE: To apply expert systems technology to submarine doctrine management. At present, management of submarine weapons employment doctrine is largely a manual task. During time-critical functions, the weapons control operator is overloaded by a combination of doctrinal and weapons preparation tasks. Automation of doctrine analysis using rule-based or other artificial intelligence techniques could significantly reduce the manual workload. Such an approach would include a conversational interface between the expert system and the operator to allow "If Then" directives such as "if a contact moves within a specified range, alert the operator to perform a specified action." In addition, this expert assistant would exploit recently available computing resources (e.g. desk-top computers, parallel processors) such that it would run in parallel with the Fire Control System thus avoiding additional loading on the FCS resources.

DESCRIPTION: Phase I: Should identify operator intensive applications which could be mitigated by this approach. Analysis should be performed to establish selection criteria and candidates chosen.

Phase II: Should provide a prototype of the system implementing one or more application for proof of concept.

N91-133 TITLE: Application of Advanced Processor Architecture to Submarine Combat Control and Acoustic Systems

CATEGORY: Exploratory Development

OBJECTIVE: Identify areas of improvement in future systems through technology infusion. Assess current and future combat control and acoustic applications and determine the use of evolving processor architectures (e.g. parallel processors, RISC processors, etc.).

DESCRIPTION: Phase I: Should explore the feasibility of utilizing advanced processor architectures within the CCS and acoustic systems.

Phase II: Should refine the concepts identified during Phase I, and provide analyses/modeling to support proposed approaches.

N91-134 TITLE: ASW Targeting Solution Integration

CATEGORY: Advanced Development

OBJECTIVE: Provide a technique to determine a "best" range/solution estimate from a set of targeting solutions based upon various sensor data and algorithms. This technique is needed to support the ASW Tactical Decision Aid and various combat control systems.

DESCRIPTION: A time/range plot is maintained by the Submarine Combat Control System to illustrate contact range history for various target range solution estimates. A method is needed to consolidate this information into a "best" contact range estimate based upon the current environment, tactical situation and available sensor data. A knowledge based TMA aid could assess the uncertainties associated with various techniques and sensors, correlate solutions with available intelligence, and present to the user a candidate "all-source/best" solution.

Phase I: It is expected that Phase I would provide an in-depth report on analytical methods/procedures developed which demonstrates the feasibility of the technique using synthetic data.

Phase II: Prototype computer-based system which could be tested at-sea under realistic conditions.

N91-135 TITLE: Submarine Countermeasures Against New Technology Active Sonars

CATEGORY: Exploratory Development

OBJECTIVE: Develop new methods which can be used to counter detection attempts using the new technology active sonars.

DESCRIPTION: New technology active sonars represent an increasingly dangerous threat to the US submarine fleet. Jamming and other countermeasure strategies are needed to render this technology ineffective. Innovative techniques for jamming, or other counter measure techniques for making these sonars ineffective, should be proposed and methods for evaluation of these techniques against existing and future sonars identified.

Phase I: The threat will be examined and its operational impacts assessed. Methods to nullify this threat will be identified as well as methods for their evaluation.

Phase II: The most promising techniques will be evaluated as appropriate via the most suitable methods proposed.

N91-136 TITLE: Submarine Combat System Operator Training Workstation Concepts

CATEGORY: Advanced Development

OBJECTIVE: Explore innovative methods of training combat system operators.

DESCRIPTION: Techniques should include methods for building operator confidence through interaction with simulated and real world data of varying complexity. New technology submarine combat systems present operators with a complex set of fire control, sonar system, and environmental operating parameters. Recent advancements in workstation technology and training systems invite innovative methods for the development of an affordable trainer. Workstation based techniques which present the operator with an interactive learning environment which can build confidence and measure effectiveness are needed.

Phase I: Examine various concepts for feasibility of implementation and plausibility of effectiveness.

Phase II: Utilize standard desktop hardware and software to demonstrate operator performance enhancements.

N91-137 TITLE: High Frequency Sonar Windows

CATEGORY: Engineering Development

OBJECTIVE: Reduce insertion losses and increase strength to withstand under-ice operations of high frequency sonar windows.

DESCRIPTION: High frequency, high strength sonar windows are required for submarine applications at locations that make them highly susceptible to damage from impact of objects in the water. During arctic operations they are also exposed to ice loads and fast changing temperature extremes associated with surfacing through the ice. Current designs call for epoxy resins reinforced with glass fibers. Graphite reinforced plastic windows with foam cores have proven to be too frail for arctic operations.

Phase I: Investigate new acoustic materials for use in high frequency sonar window applications.

Phase II: Fabricate several composites and conduct testing. Select materials and reinforcement for use in Kevlar dome and windows. The contractor will be expected to deliver the required procurement specification for inclusion in the system procurement solicitation for Phase III.

N91-138 TITLE: Expert Systems in Engagement Planning

CATEGORY: Exploratory Development

OBJECTIVE: To apply Knowledge-Based Systems (KBS) to the increasingly complex problem of planning the employment of sea-launched cruise missile.

DESCRIPTION: At present, the engagement plans of sea launched cruise missiles are confined to single route to the target. For a salvo launch, all missiles must fly the nominal route. Nevertheless, the time required for the weapon control system operator to prepare the plan is approaching the limits of the tactical window of opportunity. Future missions will require not only

geographic dispersion of multiple missiles, but also time-of-arrival control, coordination with other launch platforms, and careful selection from an expanding array of missile variants. For these and other reasons, some of the decisions presently made by the operator will of necessity be made by the Fire Control System. Prior deterministic implementations of such logic have proven to be expensive, error-prone, and operationally inefficient. Therefore, Rule-Based, Knowledge-Based, and other non-procedural approaches should be investigated for applicability to this problem. These approaches should take advantage of the projected availability of new computing resources aboard launch platforms such as parallel processors, desk-top computers, etc.

Phase I: Explore the feasibility of using KBS and/or other expert systems approaches to the projected engagement planning challenge.

Phase II: Development of a prototype on a desk-top computer similar to those available on launch platforms.

N91-139 TITLE: Sonar System Software Migration

CATEGORY: Exploratory Development

OBJECTIVE: To identify and develop innovative techniques which support the migration of sonar system application code to next generation processing systems.

DESCRIPTION: Processing requirements for next generation sonar systems require use of parallel distributed processing systems. with these new systems come new languages and programming methodologies. Without the use of automated techniques for migrating existing applications to these new systems, the transition will be time consuming and costly. Techniques and computer-assisted implementation of these techniques are sought which will support the migration of existing, functionally correct software to such systems. Particular attention should be paid to the migration of SPL based systems to new languages such as Ada/ECOS.

Phase I: Define the problem and identify, analyze, and compare alternative techniques.

Phase II: The most promising techniques will be evaluated by demonstrating software migration using portions of existing sonar system application code.

N91-140 TITLE: Alternative Means of Communication with Deployed Submarines

CATEGORY: Exploratory Development

OBJECTIVE: To explore the feasibility of providing a secure alternative means of communication with deployed submarines.

DESCRIPTION: New methods for submarine communications will be required as current networks become saturated with data being transmitted from multiple users. An alternate means of communications with submarines needs to be developed which limits the submarines's exposure during transmission/reception of radio communications.

Phase I: Should explore the feasibility of alternatives communications methodologies for submarine application.

Phase II: Refine and prove the concepts identified during Phase I through analysis and/or modeling.

N91-141 TITLE: Trident Command and Control Over-the-Horizon Communications

CATEGORY: Exploratory Development

OBJECTIVE: To provide the capability for TRIDENT submarines to receive over-the-horizon targeting (OTH-T) communications data.

DESCRIPTION: TRIDENT submarines do not currently receive all of the OTH data that is available to other fleet elements. Alternative methods for obtaining and processing this data onboard TRIDENT submarines as a stand-alone capability should be explored.

Phase I: Should explore the use of state-of-the-art technologies to provide stand-alone capability.

Phase II: Should provide a prototype of the concept defined in Phase I.

N91-142 TITLE: Long Term Storage Impact on Traveling Wave Tube Life

CATEGORY: Advanced Development

OBJECTIVE: To provide information on maximizing traveling wave tube life (DECOYS).

DESCRIPTION: Active electronic off-board countermeasures (OCMs) are considered the most effective EW technique to protect ships of the fleet against the anti-ship cruise missile (ASCM) threat. OCMs operating at high powers require microwave tubes, such as magnetrons, crossed-field amplifiers, or TWTs as the source; TWTs are often the tube of choice for OCMs requiring broad bandwidth in addition to high power. In turn, TWTs require thermonic cathodes as the source of electrons for the power tube beam. OCM TWTs must not only be capable of providing the required power-bandwidth performance, but also be able to function quickly after long shelf storage and brusque handling.

Recent attention to the use of TWT-based OCMs after long shelf-storage has indicated that the cathode is a key factor in successful OCM use. Accordingly, to achieve a better understanding of cathode properties contributing to more effective OCMs several technical issues must be fully understood. How sensitive to fabrication/processing techniques are the fast-warm-up properties of thermonic emitters? Is one cathode vendor able to produce cathode assembly, better cathode materials, or improved fabrication/processing? After extended shelf life, how sensitive are cathodes to poisoning from gases found in the tube as a result of tube processing or from other sources? Although several recently completed and ongoing studies are contributing to the overall understanding of this problem, an objective evaluation based on sound methodology would contribute to reliable and affordable TWT-based OCMs.

Phase I: Would begin with the collection and review of all available data and information on TWT operation after long shelf life storage. The data and information shall derive from the Services, TWT manufacturers and vendors, and cathode manufacturers and vendors. For non-operable TWTs, the cause of failure shall be clearly identified; for operable TWTs, cathode type, cathode vendor, cathode turn-on time, measurement technique, and other relevant factors, shall be clearly identified and reported in order to prioritize the susceptibility of TWT cathodes to poisoning or failure after long shelf storage. A ranking of cathode by type, vendor, application, etc. shall be the result of the Phase I effort.

Phase II: Would entail a laboratory evaluation of the ranked cathodes from Phase I to identify the major factors associated with cathode fabrication/processing that contribute to long TWT shelf life. The methodology should address the effect of residual gases, such as CO^2, Cl, H_2O, etc., on cathode reactivation times. The final report should clearly link "cause and effect," and include a plan to incorporate the top-ranked cathode materials and fabrication/processing techniques into production TWTs

N91-143 TITLE: Microwave Filter

CATEGORY: Research

OBJECTIVE: Development of a microwave tunable filter suitable for use in radar transmit/receive modules.

DESCRIPTION: Many modern radar and communications concepts employ microwave transmit/receive (T/R) modules. It is desireable to use a T/R module with a large bandwidth. However, using broad band modules without filter selectivity results in susceptibility to receiver images. Additionally, selectivity permits higher power amplifier efficiencies. It is desired that an innovative tunable filter be developed and demonstrated for T/R module use. Such a filter would have Phase III applicability in an array of commercial and military equipments.
Such a filter should have characteristics of the following order:

Frequency:	1 to 20 Ghz (One filter type need only cover a 60% bandwidth)
Bandwidth:	Less than 10% of center frequency with 60 dB suppression
Power Handling:	Greater than 30 dBm
Tuning Response:	Less than 10 microseconds
Insertion loss:	Less than 0.5 dB
Size:	Compatible with a single element T/R module
Power:	Less than 250 milliwatts

Phase I: Propose potential filter concepts for Phase II construction and evaluation.
Phase II: Perform detailed design, build, and test of candidate filters.

N91-144 TITLE: Microwave Propagation

CATEGORY: Research

OBJECTIVE: Quantitatively verify existing computer program microwave propagation models.

DESCRIPTION: Propagation of microwave energy at altitudes below several hundred feet is effected by several factors including frequency and air refractivity. This phenomena is commonly referred to as ducting and can result in enhanced or reduced microwave energy at a given range. Computer program models have been developed which predict duct associated propagation. However, the validity of the models has not been verified. Phase III work is expected in commercial communications applications.

It is requested that a comprehensive verification of the models be made. This verification at a minimum would consist, of microwave energy measurements as a function of frequency, altitude, sea state, and refractivity profile. The resulting data would be reduced and compared with computer program model predictions.

Phase I: Prepare a comprehensive test plan.

Phase II: Conduct tests and prepare the required reports.

N91-145 TITLE: Carbon Dioxide Reduction and/or Removal Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype carbon dioxide reduction and/or removal system for use on submarines.

DESCRIPTION: The Navy desires a concept or system which is capable of reducing respired CO_2 to O_2 as a byproduct. The Navy is also searching for an alternative concept or system for CO_2 removal CO_2 can be reduced directly from the submarine atmosphere or from a pure stream. Conversion efficiency should be greater than 90%. Phase I will consist of defining CO_2 reduction concepts and conducting initial tests of systems. Currently CO_2 is removed by absorption utilizing monoethanolamine. Other gases, particularly O_2 and N_2 are not affected. Size, weight, power consumption, reliability, and safety are critical parameters.

Phase I: Define a concept and conduct initial testing of systems capable of removing 18 lbs/hr at an inlet concentration of 0.35% CO_2 in air.

Phase II: Combine these concepts where feasible and build a prototype system for testing. The Navy may choose to build individual systems.

N91-146 TITLE: Development of Smoke Filters

CATEGORY: Exploratory Development

OBJECTIVE: To develop a filtering device for cleaning up a submarine's atmosphere following a fire.

DESCRIPTION: Submarine fires are characterized by thick toxic smoke, reducing visibility and impeding the ability of the crew to fight the fire and maintain ship control. This dangerous situation has been experienced several times on U.S. and Soviet submarines, with the most recent incident being the Mike class Soviet SSN in 1989. Overboard ventilation cannot be relied upon as the only effective means of removing fire gasses because of the susceptibility to acoustic and non-acoustic detection and the inability to guarantee surfacing during under ice operations.

Phase I: Define concepts and conduct initial testing of filters capable of removing particulate matter and gasses from a submarine fire.

Phase II: Build and test a full scale prototype smoke filter.

N91-147 TITLE: Modeling Shipbuilding Contract Changes

CATEGORY: Exploratory Development

OBJECTIVE: Develop a personal computer (PC)-driven mathematical model to forecast the cost and schedule effects of individual ship construction contract changes.

DESCRIPTION: Flow chart and prototype a PC-driven model, hosted on application software commercially available in the United States, that predicts the cost and schedule impact (increase, decrease. no change) of individual ship construction contract changes. The model must be capable of accommodating the full range of potential changes, including addition, deletion, modification, interruption or acceleration of work processes or material. It must predict the core cost of the change as well as the impact of delay and disruption on a contract for construction of a single ship. For both Phase I and Phase II, the Navy wishes full rights in technical data for the flow charts, source code and object code developed.

Phase I: Develop a personal computer (PC)-driven mathematical model to forecast the cost and schedule effects of individual ship construction contract changes.

Phase II: Expand the model to accommodate any shipbuilding program assuming the provision of contractor-selected data commonly available to the Navy, including multi-ship construction programs.

N91-148 TITLE: Cold Weather Logistics Over-the-Shore (LOTS) Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Identify cold weather LOTS improvement concepts, establish feasibility, develop and test prototype systems

DESCRIPTION: Phase I: Identify hardware improvement concepts to reduce icing and personnel hazards on causeways, lighterage, and ships involved in cold weather LOTS operations. Establish concept feasibility, systems should be portable, retrofittable, and easy to install and use.

Phase II: Develop and test prototype systems to quantify performance improvement (spray reduction, ice removal or prevention, or personnel protection).

N91-149 TITLE: Optical Fiber Neutron Dosimeter

CATEGORY: Exploratory Development

OBJECTIVE: Device which uses the change in optical transmission to measure neutron radiation

DESCRIPTION: Phase I: Test candidate fibers to select ones with high sensitivity to neutrons and linear response.

Phase II: Construct prototype dosimeter with chosen fiber test for adherence to requirements for Neutron Dosimetry System.

Phase III: Develop a production model for Navy use.

N91-150 TITLE: NAVSEA Integrated LSA Process Model

CATEGORY: Engineering Development

OBJECTIVE: To develop a NAVSEA Integrated LSA Process Model.

DESCRIPTION: A process model is developed by identifying the "external agents" which would be any activity or organization responsible for creating, using, reviewing, maintaining or authorizing ILS data; the "data flow" which traces the flow of the data through the ILS support systems; the "data stores" which represent a logical file or collection of data and would be identified as the required ILS products; and the various ILS support "process" which transform the data and result in some type of value added data. The process model would use a Computer-Aided Software Engineering (CASE) tool which facilitates modeling development to identify and document the Integrated LSA process. This model would be unique to any other since the objective is to identify the information flow among LSA and all ILS elements.
The utility of an integrated LSA process model would be the identification of redundancy within the ILS support process, to provide a common baseline to serve as the acknowledged point of departure for all ILS guidance and policy implementation and to support the development of the Computer Aided Logistics Support Integrated Work Breakdown Structure Database (CALS IWBSDB.

Phase I: Deliver the documented, integrated process.

Phase II: Use the process defined in Phase I to develop and demonstrate a computerized program of the process.

N91-151 TITLE: 'C2 Trusted Automated Information System (AIS)' Security Accreditation INIT/CDEV Support for Small Computer System Interface (SCSI) Micro-computers Equipped with a Local Area Network (LAN)

CATEGORY: Engineering Development

OBJECTIVE: Design, develop, test, evaluate and submit for accreditation by the National Security Agency (NSA) Computer Security Association; INIT/CDEV routines hosted on a SCSI-based, LAN-equipped micro-computer necessary to support all AIS requirements comprising a 'C2 Trusted Automated Information System' per DoD 5200.28-STD (orange book), and providing:

Criteria, per DoD 5200.28-STD	Additions to DoD 5200.28-STD
Discretionary Access Control	Add: 'No Trespass' warning upon boot; membership control for groups of users; and control access to SCSI/LAN peripheral(s) by groups.
Object Reuse	Include: SCSI and LAN peripherals containing memory/storage elements; (eg: disks, scanners, printers, etc) all micro-processor Cache RAM.
Identification and Authentication ...	Add: an authorized users list; non-vocabulary passwords for each user; and group-unique keyboard procedures.
Audit	Export the event log in LOTUS or EXCEL format (a user option). Record each access to SCSI/LAN peripherals.
System Architecture	Interrogate the SCSI/LAN networks; recognize authorized peripherals; log all responses.
System Integrity	Deny access to unauthorized SCSI/LAN peripheral(s). Provide operator security messages if unauthorized peripherals are detected.
Security Testing	Recognize and log every INIT and CDEV present at boot-up; Provide access to authorized INITs and CDEVs only

In addition to the INIT/CDEV support, the Contractor shall plan, outline, draft, edit, and submit for comment and review and revise as directed; the following documentation supporting the 'C2 Trusted Automated Information System' accreditation:

Criteria per DoD 5200.28-STD	Documentation Comment
Security Features User's Guide ...	Include a performance and micro-computer resource requirement(s) description of each 'C2' Security feature.
Trusted Facility Manual	Include an operational guide to each 'C2' Security feature.
Test Documentation	Include daily and other periodic confidence tests for use by organizational level security personnel.
Design Documentation	Include: all system analyses; flow charts & Kepner-Tregoe diagrams; and source code with detail comments referencing the page & paragraph of the micro-computer manufacturer's hardware and software technical manuals.

Exception to SBIR Technical Data Rights Contractual Consideration: Relevant proposals shall; 1) provide the Government with unlimited royalty free rights in data for software and documentation either developed or delivered under Contracts resulting from this Topic and; 2) shall not propose any existing software or documentation for government use or delivery unless unlimited royalty free use has been granted to the Government prior to the proposal date

DESCRIPTION: Phase I: Deliver an Alpha-test version of the INIT/CDEV supporting the first four security criteria. Provide alpha-test typed drafts of the 'Design Documentation', 'Trusted Facility Manual', and 'Test Documentation' as appendices to the final report, and concurrently with the alpha-test version of the INIT/CDEV. Phase I offerors are advised that only two micro-computers are contemplated in this solicitation: the IPM/PC (and compatibles) and the Apple Macintosh-II (x, cx, ci, and fx models); for each computer type, multiple awards are contemplated in Phase I, and selection of a Phase II contractor may be based upon competitive criteria including evaluation of the delivered alpha-test Init/Cdev version. Phase II proposals by any Contractor not delivering an alpha-test INIT/CDEV shall be returned as; not relevant.

Phase II: Task I: Prepare, submit and revise as necessary a Beta-test version of the Init/Cdev as necessary to meet the requirements of DoD 5200.28-STD and all 'C2' security criteria, and prepare, revise and deliver the 'C2' documentation concurrently with the Beta-version INIT/CDEV. Receive and maintain a complete log of all Beta-test comments received on the INIT/CDEV and the documentation, and annotate each comment with the action taken, date of patch/modification, etc.

Task II: Upon written authorization of the Contracting Officer, prepare, submit and revise as necessary a Delta-test INIT/CDEV version and the 'C2' documentation necessary to obtain 'C2 Trusted Automated Information System' accreditation from the NSA. Task II may not be authorized for any contractor not delivering a satisfactory Beta-test INIT/CDEV version, nor for any contractor having Beta-test comments not resolved and satisfied to the satisfaction of the Contracting Officer's Technical Representative.

NAVAL SURFACE WARFARE CENTER

N91-152 TITLE: Advanced Multiple Target Recognition Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop an intelligent multiple target recognition system.

DESCRIPTION: In tense situations, when a wealth of sensor information is obtained from several potential targets, conventional approaches for correlation of this information is time consuming and may result in faulty decisions. An intelligent decision making system can be used in conjunction with sensors and weapons to defend against threats. In the case of multiple targets, the system must discriminate among friendly, non-hostile, and hostile targets and to engage only the hostile targets. Combined artificial neural networks and expert systems techniques and parallel computer architectures can play an important role in decision making and prioritizing targets for engagement.

Phase I: Investigate new approaches to a multiple target recognition system that is capable of autonomous recognition of multiple targets using multi-sensor information. The system will utilize both the qualitative and judicative reasoning process of human experts, as well as the capabilities of most probabilistic techniques. The result of the Phase I effort should be a report detailing the contractor's methodology for solving the problem and providing a detailed discussion of a proposed system design.

Phase II: Create a brassboard/simulation of the contractor's solution demonstrating the real time, improved capability.

N91-153 TITLE: RF/IR Dual Mode Sensor Integration/Fusion

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate techniques and algorithms for combining RF doppler and IR tracker outputs in order to minimize each sensor's limitations and complement their performance.

DESCRIPTION: Both RF doppler and IR trackers being employed on missiles against air targets have their own particular errors and limitations. For example, RF doppler trackers are susceptible to glint, polarization, multipath, jammers and multiple target confusion. IR trackers are susceptible to hot spot offset (e.g. plume tracking), background clutter, IR decoys, and multiple target confusion. Most of these problems only exist in one tracking regime at a time, e.g., RF multipath does not affect IR tracking, IR background clutter does not affect RF tracking, RF tracking, etc. Even multiple target confusion becomes resolvable. Multiple identical IR target signatures would usually appear as distinctly different RF doppler signatures. Techniques and

algorithms are needed to determine when to use RF or IR tracking in a dual mode tracker in order to minimize tracker degradation or loss of track. In addition, for a more advanced dual mode tracker, outputs of both sensors could be combined in order to maximize the tracker's accuracy task.

N91-154 TITLE: Application and Radiometric Characterization of Coatings

CATEGORY: Exploratory Development

OBJECTIVE: To develop a method of coating various materials to alter the infrared emittance of the material.

DESCRIPTION: Currently, most heat transfer measurements on models being tested in wind tunnels are made using coaxial thermocouples. These thermocouples are imbedded in the wall of the model. This method has shortcomings in that the model must be fabricated from specific materials, the number of thermocouples is generally limited (usually less than 50), and there is a constraint on material thickness (measurements could not be made on leading edges). These restrictions limit the number of models that can be readily tested.

Experiments indicate that infrared (IR) thermography can be used to make surface temperature measurements of a wind tunnel model. The advantage of IR thermography is that data can be obtained for up to 10 points on the model. The disadvantage is that the model surface emissivity must be known, and is often not easily determined.

It is therefore necessary to develop the capability of putting a coating on tunnel models to prepare them for IR thermography testing. This coating should be less than 20 um in thickness and have an emissivity greater than 0.85 for radiation in the 8-12 um wave band. The coating(s) should adhere to models made of a wide variety of materials, especially 17-4 PH (condition A) stainless steel and aluminum.

N91-155 TITLE: Guidance Algorithms for High Performance Missiles

CATEGORY: Advanced Development

OBJECTIVE: Develop and successfully demonstrate via simulation (at end of Phase II) of data fusion and target sorting algorithms suitable for anti-air high performance homing missile applications.

DESCRIPTION: The need exists for innovative approaches for combining data from multiple sensors and establishing multiple track files for homing missiles. Possible sensors are RF active and/or semi-active, IR, and ARH both in and out of band. The processing must be done in real time on board the missile and be able to successfully accomplish this task in the expected multiple target environment. This environment includes multipath effects, both standoff and self screening deceptive techniques, target maneuvers, and the potential use of decoys. The algorithms must be compatible with current or near term state-of-the-art sensor technology.

N91-156 TITLE: High Power Density Actuators

CATEGORY: Advanced Development

OBJECTIVE: Successful fabrication and demonstration of an actuator that achieves rates up to 1000 degrees/second in the presence of up to 2000 in-lbs of torque that is suitable for a high performance missile tail fin servo.

DESCRIPTION: The need exists for a small high power density electro-mechanical actuator suitable for implementing in small anti-air missiles. These missiles may be no more than 9" in diameter with the actuators to be located in the annulus around the exhaust nozzle. In order to meet the missile performance requirements, actuator rates up to 1000 degrees/second may be expected in the presence of up to 2000 in-lbs of torque. Flight times are typically less than 20 seconds and the primary power source will be thermal batteries. It is recognized that these requirements stress the traditional electro-mechanical system approaches and therefore an innovative approach to missile actuation is required.

N91-157 TITLE: Optical Neural Networks for Automatic Target Recognition

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate an advanced optical neural network system to support a wide range of military real time pattern recognition applications.

DESCRIPTION: Neural nets provide high speed and fault tolerant associative memory, target classification and data or feature extraction from partially obscured or degraded sensor information. Actual physical realizations of neural networks require a highly interconnected and parallel architecture. Optical neural network implementations can exceed most, if not all, of the present capabilities of electronic or software based implementations. Using optics it is potentially possible to obtain up to 1 Giga association per second, 1 Giga interconnections per cubic centimeter of optical materials using holographic interconnects and 10 to the 18th (Exa) interconnects per second. Optical systems can also provide weight, volume and power advantages over electronic systems, which make them suitable for use in relatively small mobile platforms, such as RPV's and missiles. In addition to processing radar, IR, and video sensor information, such a system could also be used for spread spectrum communications, which cannot be implemented at this time due to the limitations of digital pattern recognition systems. Innovative neural network system concepts using new, optically implementable paradigms or novel architectures, and/or advanced device/materials applications are sought.

N91-158 TITLE: Integrated Photodetectors for Optical Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate advanced photodetector devices, with onboard preprocessing and high speed A/D conversion, for use in optical signal processing systems.

DESCRIPTION: Ultra-high speed optical signal processing systems still require a photodetector or sensor at the image plane, to sense and record the output. This creates a bottleneck at the optical interface because the parallel processed optical information has to be converted to digital bit streams. Major improvements in two dimensional output detectors are necessary in terms of spatial sampling, resolution, temporal sampling, dynamic range, geometric fidelity, image preprocessing, buffering and A/D conversion, to improve data output. Offerers should consider an integrated device approach which includes the detector array and on-chip processing, such as analog time integration or filtering, and A/D conversion.

N91-159 TITLE: Aerodynamic Activated Metal Decoy

CATEGORY: Advanced Development

OBJECTIVE: Activated metals and aerodynamic decoys are in engineering development. This task will investigate innovative approaches to marrying these engineering technologies.

DESCRIPTION: The MJU-27/B IR decoy uses activated metal as its IR element. The MJU-20/B and MJU-29/B are examples of aerodynamically stable decoys. This task will investigate innovative approaches to marrying the underlying technologies of these devices to conceptualize an aerodynamic activated metal decoy. Contractor will require access to classified information; therefore, personnel and facility clearances at the SECRET level are required for Phase I and Phase II. NWSC SBIR office will provide required specifications.

N91-160 TITLE: Methodology for Predicting Fragment Induced Damage to Operating Rocket Motors

CATEGORY: Exploratory Development

OBJECTIVE: Develop methodology to predict the damage resulting from warhead fragments striking operating rocket motors.

DESCRIPTION: Methodology shall be developed to predict the failure of an operating rocket motor attacked by warhead fragments. The rocket motors of interest include both end-burning and center-burning. For the end-burning, impacts on both the gaseous and solid sections of the motor are of interest. For the center-burning, the thickness of the propellant shall vary from close to the maximum thickness (unburned) and close to the minimum (completely burned). Of particular interest is the dual-thrust end-burning motors. This type of motor burns at a higher pressure during launch. As a result, at the time of encounter, the motor is not as close to its burst. The primary fragment variables are impact, speed, size and pattern density.

Phase I: The effort would involve postulation of the failure mechanisms, a predictive methodology and a general test plan.

Phase II: The effort would involve specific test planning, conduct of the tests and finalization of the model.

N91-161 TITLE: Post-Intercept Trajectories of Missile Debris Fragments

CATEGORY: Exploratory Development

OBJECTIVE: To develop prediction methods to characterize the post-intercept behavior of fragments of antiship cruise missile threats.

DESCRIPTION: To better defeat modern antiship cruise missile threats, Navy surface ships must have detailed information about the post-intercept behavior of the individual components of the threat. Details of the most-likely motion characteristics of the various missile components after break-up are needed to rapidly verify the possibility of the elimination of the threat. It is also important to know the impact region or footprint of the various threat components to assess the likelihood of damage to the targeted ship or others in the vicinity. An analytical method applicable to current and future threat configurations is desired

Phase I: Define a computational approach for the prediction of the post-intercept behavior of antiship cruise missiles, develop and demonstrate the methodology for several classes of modern threats, and describe various approaches to validate the prediction methodology.

Phase II: Define the methodology developed in Phase I and apply it to specific Navy problems, develop the methodology into a computer code including pre- and post-processing capability, and validate the prediction method with available experimental data. The final computer code will be documented and delivered to the Navy complete with user training course and post-delivery support.

N91-162 TITLE: Integrated Computing Environment for Vulnerability Modeling

CATEGORY: Exploratory Development

OBJECTIVE: Develop an integrated computing environment for vulnerability modeling on a high performance graphics. workstation.

DESCRIPTION: Air Threat vulnerability assessment data is used in ordnance design and weapon system effectiveness analysis. This data needs to be produced much more quickly to be responsive to the weapon design and analysis process. The vulnerability modeling process involves the development of computerized geometric models, shotline analysis of the geometric models, the implementation of penetration equations into the shotline codes, and a variety of other ancillary tasks. Much of the software for vulnerability modeling dates back to the days of batch machines and punched card input. The entire process would benefit greatly by integrating the various computer codes onto a high performance graphics workstation utilizing modern database techniques, graphical user interfaces, and such. Considerable time and cost can be saved with a surface energetic state-of-the-art process.

Phase I: Literature, and NSWC hardware survey, overall concept development and preliminary system design

Phase II: Software development, demonstration and documentation

N91-163 TITLE: Ergonomic Replacement for Naval Console Trackball

CATEGORY: Exploratory Development

OBJECTIVE: Develop a replacement for the trackball which is currently utilized on many of the consoles aboard Navy ships.

DESCRIPTION: Recently published reports on currently available hardware indicates that a mouse, graphic tablet, isometric fingertip joystick and touch-sensitive screen are the better means for pointing and manipulating data on a display than a trackball. To enhance and increase the response time for a shipboard Navy operator on a display, the track ball as a data-entry-port/cursor manipulator needs to be examined and re-evaluated, and possibly replaced/upgraded, for today's needs and concern.

Phase I: The use of a trackball consumes a large quantity of a fire control operator's time. This area is ripe for the incorporation of new ergonomic principles and state-of-the-art technologies for the Navy. Conversely, a bad user interface may make things so difficult for the operator that the system is inefficient and unusable.

Phase II: Develop an effective user-system interface that makes the system not only easier to learn but also easier and more efficient to operate.

N91-164 TITLE: New High Surface Energetic Materials for Use in Slapper Devices

CATEGORY: Exploratory Development

OBJECTIVE: Synthesize new high surface area energetic materials to replace the explosive HNS for use in slapper devices.

DESCRIPTION: The explosive hexanitrostilbene (HNS) is a thermally stable explosive that easily meets the requirements listed in Weapon Specification 32972 for slapper performance. HNS is expensive to make; furthermore, the procedures used currently to make HNS result in waste products that require extensive processing before disposal.

Requirements: (1) a candidate replacement must function normally in slapper devices, with a minimal change in hardware configuration; (2) the candidate replacement must be less expensive to make than HNS; (3) the by-products produced by the synthesis of the candidate replacement must be disposable in an environmentally safe manner with a minimum of costly pre-processing; (4) the candidate replacement must be less sensitive than the explosive Tetryl in all sensitivity tests.

Phase I: Effort should be directed toward identifying the commercial source or the method of synthesis of candidate replacements. Small quantities of these candidate replacements shall be purchased and methods devised to make those materials that cannot be purchased. Twenty grams of each of the promising candidate replacements shall be forwarded to NSWC for characterization and evaluation in slapper devices.

Phase II: Effort shall be directed to the large scale preparation of candidate replacements selected by NSWC; methods should also be devised to reduce costs. Additional research will be required to optimize the slapper performance of these materials. Sufficient quantities of the candidate replacement explosives shall be forwarded to NSWC for evaluation.

N91-165 TITLE: Infrared Propagation Near the Sea-Air Interface

CATEGORY: Exploratory Development

OBJECTIVE: Develop an analytical model for infrared propagation at altitudes less than 100 feet shall be assembled.

DESCRIPTION: The development of a model of the optical propagation in the atmosphere above the sea-air interface and its verification through experimental measurements. The surface Navy must have the ability to detect and track targets such as cruise missiles at very low altitudes. Near the sea surface, the propagation is often affected by the high humidity, aerosols, and temperature gradients. Refractive as well as scintillation effects are often seen in the visible region of the spectra. Infrared imagery can also be drastically affected by the high humidity conditions at sea and some ducting may occur.

Phase I: Must include a design or breadboard system for conducting measurements over water ranges.

Phase II: Optical measuring equipment should be assembled and experiments be conducted over water ranges. Empirical data will be compared with the model developed during Phase I.

N91-166 TITLE: Weapons Control Icon Development

CATEGORY: Exploratory Development

OBJECTIVE: To develop standardized icons for use in Naval weapons control systems.

DESCRIPTION: Significant research and development is currently being done commercially on personal computer systems using icons for menu selections as opposed to typewritten commands. Icons are familiar objects or commands represented by small pictures. Use of icons is based on the principle expressed in popular literature as; "recognition is generally easier than recall". Icons developed and used on personal computers have been shown to be extremely easy for the user to understand, easy to train in minimal time, and very easy to recall. Due to the tremendous success of icon-based personal computer system menus, research should be conducted on applying similar principles to weapons control. Designers must first understand who their users are and what their needs are.

Phase I: Develop and test a set of standardized candidate icon designs and describe them in language and diagrams appropriate for military standards and specifications.

Phase II: In an environment where accuracy and speed are critical, each innovation which increases the probability of a successful mission completion must be explored, developed, and implemented. Designers must study the respective cognitive, behavioral, anthropometric, and attitudinal characteristics, as well as the mission to be accomplished, and validate (and modify as necessary) the candidate icons and icon design descriptions developed in Phase I.

N91-167 TITLE: Coated Boron Combustion Studies

CATEGORY: Exploratory Development

OBJECTIVE: To measure combustion reaction times (10^{-4} to 10^{-6} seconds) of 0.1 micron or less thickness aluminum or magnesium coated boron at temperatures up to 2500 degrees K.

DESCRIPTION: Ignition delays during metal combustion are detrimental to metal fuel performance. Ignition of uncoated boron particles is inhibited by the formation of a boron oxide layer which places a physical barrier between the metal and oxidizer. It is postulated that two-stage ignition occurs with boron, because the rate of oxidation is slowed by the oxide formation, with subsequent evaporation of the oxide layer and reheating. Aluminum or magnesium coated boron particles may permit the coating metal to react first, which may provide the heat necessary to raise the temperature of the underlying boron above the boron oxide volatilization temperature; therefore it is of interest to study the combustion of thinly (0.1 to 0.01 micron) coated small (diameters less than 5 microns) boron particles at temperatures up to 2500°K, expansion ratios of up to five to one, and reaction time resolution from milliseconds to microseconds.

Phase I: Research should focus on the ability to determine the parameters described in the above objectives.

Phase II: Research should further develop the experimental techniques to characterize expanded combustion conditions. In addition relate changes made in coating thickness and particle size to the observed changes in particle reactivity.

N91-168 TITLE: Production of Aluminum Powder with Aluminum Fluoride Coating

CATEGORY: Advanced Development

OBJECTIVE: To produce fine particle size aluminum powder with a passivating coating of aluminum fluoride rather than aluminum oxide.

DESCRIPTION: The heats of detonation of aluminized explosives and propellants are, in general, considerably higher than for non-aluminized materials. It has been suggested that, in order for aluminum to deliver energy in an explosive or propellant, the temperature of the aluminum must be above the boiling point of the oxide coating that protects the surface of an aluminum particle. It is possible that the substitution of a fluoride coating in the production of the aluminum powders to be used in explosive or propellant formulations would lead to more rapid shedding of the protective coating and hence earlier participation of the aluminum in the detonation. If this earlier participation were to occur, it might make it feasible to use aluminized materials in applications that are usually reserved for ideal explosives, thus making higher energy explosives available for metal driving applications.

Phase I: Should consist of an effort to produce fine particle (5 micron) spheroidal aluminum with a thin passivating coating of aluminum fluoride rather than aluminum oxide. The aluminum thus produced should be characterized as to the thickness, perfection and stability of the coating in the presence of moisture. Gram-sized samples of the material produced should be provided to the Navy for evaluation

Phase II: If the feasibility of producing AlF_3 coated aluminum is demonstrated, Phase II should address the scale-up of the process and delivery of several pounds of the material to the Navy for incorporation into explosive formulations. It should also include plans to compare the kinetics of the reaction of the AlF_3-coated aluminum with various oxidizers (such as 0_2 , H_2O, and/or CO_2) at high temperatures to that of commercially available aluminum of comparable particle size.

N91-169 TITLE: Coating of Anhydrous Lithium Perchlorate (LP)

CATEGORY: Exploratory Development

OBJECTIVE: To produce anhydrous lithium perchlorate coated with an inert material that will reduce the hygroscopicity of the LP.

DESCRIPTION: Many explosives and propellants contain ammonium perchlorate (AP) as an oxidizer. Calculations have indicated that replacing the AP with lithium perchlorate (LP) could lead to significant enhancements in performance in these materials. However, the use of lithium perchlorate presents many problems, among them being the hygroscopicity of LP and the sensitivity it confers on some formulations

Phase I: A study of coating anhydrous LP with a thin coating of some material that will (1) reduce the hygroscopicity of the coated LP and (2) not make it more sensitive to impact than uncoated anhydrous LP. Attention should be paid to the thickness and perfection of the coating. Samples of the coated material should be provided to the Navy for evaluation.

Phase II: Scale-up of the process for coating the LP and production of several pounds of the coated material for evaluation by the Navy.

N91-170 TITLE: Technologies to Accelerate Heterogeneous Reactions Producing Energetic Material

CATEGORY: Exploratory Development

OBJECTIVE: To accelerate the rates of heterogeneous reactions used in the synthesis of high energy compounds by means other than bulk elevated temperature.

DESCRIPTION: Many valuable high energy compounds are synthesized using heterogeneous reactions which are very slow under reaction conditions amenable to scale-up. Examples are thermally stable polynitropolyphenyls which require high temperature Ullman reactions for their synthesis, synthesis of aliphatic fluoronitro compounds by exceedingly slow displacement reactions with potassium fluoride, and synthesis of polycyclic and cage aza compounds by amidealdehyde condensations via highly insoluble intermediates. Acceleration of these reactions by heating is often not feasible on a large scale because products or intermediates are not stable and/or the hazards involved are prohibitive.

Phase I: Alternative methods to accelerate such reactions are to be identified and demonstrated experimentally.

Phase II: Feasible methods will be scaled up and used to prepare multi-kg quantities of specified high energy compounds.

N91-171 TITLE: High Temperature Boron-Titanium Chemistry with Water

CATEGORY: Exploratory Development

OBJECTIVE: To determine high temperature reaction rates of boron and titanium to the intermetallic with subsequent measurement of reaction rates and products of the intermetallic with water.

DESCRIPTION: The adiabatic flame temperature of the combination of boron and titanium to the corresponding intermetallic is predicted to be in excess of 3000 degrees K. The offeror should have an understanding of this reaction and be able to determine high temperature reaction rates to form the intermetallic with subsequent measurement of the reaction rates and products formed when the hot intermetallic and unreacted metals are reacted with water. Of interest are the conditions for ignition of the metals, reaction rates and physical form of the pre-ignited metals. Measurement of the reaction rates of the hot intermetallic and unreacted metals with water are important as well as corresponding products formed

Phase I: Effort should be directed towards experimentally proving the feasibility of igniting the boron-titanium mixtures, and understanding the chemical reactions between the intermetallic, unreacted metals and water and measuring the reaction rates via the formation of products.

Phase II: Efforts should further develop an understanding of the chemistry involved of the above described reactions and expand experimental methods to include mass balances on the reactants and products with alternate mixing techniques.

N91-172 TITLE: Predicted Tactics of Adversaries

CATEGORY: Exploratory Development

OBJECTIVE: The development of a tactical database, drawn from intelligence data and historical observations, suitable for use in surveillance planning.

DESCRIPTION: Surveillance planning systems are being developed to assist tactical commanders in the allocation of search assets. These systems have the capability to produce technically correct search plans based on previous contact data, unsuccessful searches and estimates of adversary tactics or intentions. This task addresses the problem of determining what those tactics are. Estimates should come from several sources: historical, recent intelligence, contact data and the judgement of the commander. The tactics may deal with either surface contacts, air contacts or both (submarines will be considered in Phase II).

Phase I: Produce a definitive paper study demonstrating the feasibility of building such a database for the prediction of tactics and intentions. The study should clearly show the sources of the data and the methodology and algorithms by which the predictions are made.

Phase II: Produce a full scale prototype with most of the capabilities in place sufficient for operational support to a battle group.

N91-173 TITLE: Militarized All-Optical Non-Moving Fiber Optic Switch

CATEGORY: Research

OBJECTIVE: Develop a highly reliable fiber optic switch to be used in fiber optic data transfer networks.

DESCRIPTION: Optical by-pass switches are important components for fiber optic data transfer networks. These switches can be made more reliable by using optical materials for the switching mechanism (no moving parts) and by activating the switch optically (no EMI).

The switch will employ crystals that are optically bistable so that there will be no optical-to-electrical conversion at the switch. The switch must be totally optical and have a switching speed faster than one microsecond. Signal transmission and switch activation must both occur for wavelengths of 850 and 1300 nanometers. The switch must be compatible with multimode and single mode optical transmission systems. The entire package (including fiber to crystal interfaces) must be ruggedized to withstand shock and vibration as well as other military environmental tests.

Phase I: A feasibility study and possible prototype of the switch mechanism would be the product.

Phase II: A device passing all applicable military specifications would be the result of a Phase II contract.

N91-174 TITLE: Optically Driven Quartz Crystal Shutter for Use in Sensors

CATEGORY: Research

OBJECTIVE: The development of a crystal shutter for use in all-optical sensors. Current research into optical sensors (pressure, temperature, velocity, etc.) has produced designs that rely on piezoelectric crystals which convert incident light energy to electric current.

DESCRIPTION: Materials research is sought to replace these piezoelectric crystals with a crystal oscillator that is driven at its resonant frequency by use of optic radiation. A double-ended tuning fork quartz crystal oscillator which will not allow discrete components such as diodes or photocell arrays to be located adjacent to the quartz crystal is needed. The optical radiation must be supplied by commercial LEDs or laser diodes which operate at 1300 nanometers. The optical radiation will be delivered to the quartz crystal via a 62.5 micron optical fiber. The unstressed resonant frequency of the quartz crystal oscillator will range from 10 to 100 Khz depending on the crystal dimensions.

Phase I: Produce candidate quartz crystals having the required resonant frequencies.

Phase II: Build and test up to 10 different quartz crystals having resonant frequencies of 10n Khz where n =1, 1,2, 3 ---10

N91-175 TITLE: Biocorrosion/Biodeterioration/Biofouling of Coated Metals

CATEGORY: Exploratory Development

OBJECTIVE: To understand and prevent the observed corrosion/deterioration of protected metals in cooling systems.

DESCRIPTION: Microbiologically influenced corrosion (MIC) studies of nylon coated, epoxy coated, and polyurethane coated metals used in marine seawater and atmospheric marine environment have been undertaken using aerobic and facultative anaerobic (sulfate-reducing) bacteria which have been found in Naval systems. The observed synergistic attack of chloride ion and microbial attack on these coatings (and possibly the newly exposed metal surface) is being studied using electrochemical, physical/structural, and microbial techniques. Proposals are sought for understanding the processes of algal, protozoan, fungal and other attacks of these coatings using microbial, electrochemical, and physical/chemical methods.

N91-176 TITLE: Optical Time Domain Reflectometer (OTDR) for Network Use

CATEGORY: Research

OBJECTIVE: Develop an OTDR that can be automatically switched into a fiber optic network for diagnostics and built-in-test capabilities.

DESCRIPTION: Fault location in a fiber optic network is a major portion of corrective maintenance time. It is desired that the fiber optic network administrator (computer) have available an OTDR that could be automatically switched into the network to determine if (and where) a cable/connector break is responsible for service interruption.
The major characteristics for this OTDR would include:

- All circuitry in a single hybrid microcircuit suitable for installation on a printed circuit card.
- Operation at 1300 nm for 62.5/125 micron fiber.
- Resolution of 1m over a distance of 2 kilometers.
- Electrical output of analog or digitized OTDR trace.

Phase I: A successful Phase I contract will conclude with a feasibility study for this equipment along with a breadboard prototype system.

Phase II: If Phase II is authorized, will conclude with several advance development models suitable for testing to applicable Navy standards for electronics and fiber optics.

N91-177 TITLE: Ceramic Ferrules for Fiber Optic Connectors

CATEGORY: Engineering Development

OBJECTIVE: Establish a U.S. manufacturer of ceramic ferrules for use in fiber optic connectors.

DESCRIPTION: Ferrules are the most important element of a fiber optic connector, providing the mechanism for the precise alignment of the optical fibers. Ceramic ferrules are preferred over other materials (e.g. stainless steel, plastic) for their precision, environmental stability, and ease of assembly. There are only a few manufacturers of ceramic ferrules worldwide, none of which are located in the U. S. or other NATO countries.

Phase I: A feasibility study detailing the requirements for establishing a manufacturing facility would be the product of Phase I.

Phase II: If authorized, Phase II would consist of exploratory development of a manufacturing facility.

N91-178 TITLE: Low Halogen, Flame Resistant Cable Jacket Material

CATEGORY: Research

OBJECTIVE: To develop a low halogen flame resistant cable jacket material suitable for Navy applications.

DESCRIPTION: The cable jacket materials shall be applicable for use in both high fiber count cable designs as well as low fiber count cable designs. The cable jacket material shall contain less than 2% halogens by weight and shall meet the following requirements:

Acid Gas Generation: <2 oz by weight
Smoke Generation: Dm <225 according to ASTM-E-84
Flame propagation: flame spread time product <27.5 m.min
after 10 min in UL-910 tunnel test
Fungus Resistance: Grade I MIL-STD-810
Water Absorption: <3.9 mg/sq cm of material surface area
Fluid immersion: 24 hrs in the following fluids;
Fuel Oil (33-37 deg C)
JP-5 (20-25 deg C)
Isopropyl Alcohol (20-25 deg C)
Hydraulic Fluid (48-50 deg C)
Lube Oil (73-77 deg C)
Coolant (Monsanto Coolanol) (20-25 deg C)

The tensile strength and elongation shall not change more than 50% from the initial values.

Phase I: A preliminary evaluation of all candidate materials would be the result of a Phase I contract.

Phase II: If authorized, Phase II would consist of the full scale development and testing of best candidate materials determined in Phase I.

N91-179 TITLE: Investigation of the Rechargeable Lithium Cobalt Oxide Cell

CATEGORY: Exploratory Development

OBJECTIVE: Develop and evaluate a rechargeable lithium cobalt oxide (Li/LixCoO2, methyl formate) cell that can deliver fifty, 100 Wh/lb cycles at the C/6 rate and have a shelf life of 5 years.

DESCRIPTION: The Navy is investigating the feasibility of using Li/LixCoO_2 for powering underwater vehicles. This system is very attractive because of its high theoretical energy density (500 Wh/lb) and high operating potential (4 volts). Two challenges confronting the Li/LixCoO_2 technology now are improvement of the system's charge retention capability and further advancement toward achieving a densified thin cathode. Successful resolution of these two areas will permit this technology to move from laboratory cells to hardware.

Phase I: Efforts will focus on determining the amount of lithium that can be intercalated or deintercalated in the CoO_2 structure without adverse effects on rechargeability. Voltage limits during charge and discharge will be established in order to determine if this system should be cycled to a predetermined capacity or voltage endpoint. Cells will be stored under various temperatures and state-of-charge to assess charge retention. If the system is found to lose charge excessively, the source of this failure will be investigated. A further objective is to increase the cathode density, with the overall goal of achieving a low cost process capable of producing thin, rugged, flexible electrodes.

Phase II: Investigations will refine and expand progress made in Phase I and demonstrate these improvements in prototype hardware cells. Interactions between the hardware cell components and the CoO_2 system will receive fuller evaluation with respect to cycle life and charge retention. Cathode investigations will continue to maximize density and minimize thickness.

N91-180 TITLE: Maneuvering Reentry Body Aerothermal Analysis Computer Program

CATEGORY: Exploratory Development

OBJECTIVE: Development of a computer code to predict shape change and internal temperature distributions for advanced maneuvering reentry body configurations.

DESCRIPTION: Future missions of the Navy's Submarine Launched Ballistic Missiles may require the development of advanced, high-performance, maneuvering reentry bodies (MaRB's). The external configuration of such a MaRB will probably be a complex, nonaxisymmetric shape in order to obtain the desired aerodynamic performance. The severity of the reentry heating environment will probably require the use of ablative materials on all external body surfaces. To assess the aerodynamic and structural performance of such a MaRB, it will be necessary to determine the instantaneous shape of the body and the temperature distributions within components such as nosetips, leading edges, heatshields, and control surfaces at any point in the MaRB's trajectory.

A computer program is therefore sought which can be used to predict surface shape change (due to thermochemical ablation and hydrometeor erosion effects) and in-depth temperature distributions for complex MaRB configurations.

It is expected that a Phase I effort will assess the current state-of-the-art in this area, identify an approach for constructing the desired computer code, and carry the code development at least to the point where the viability of the approach can be demonstrated.

Completion, validation, and documentation of the code will take place during a Phase II effort. At the conclusion of this phase, the code will be installed and demonstrated on the NSWC VAX computer, and NSWC personnel will receive instruction in the use of the code.

N91-181 TITLE: Realizing the Potential of Computer Aided Software Engineering (CASE) for Real Time Embedded Computer Systems

CATEGORY: Exploratory Development

OBJECTIVE: CASE can be viewed as a combination of methods and tools for developing and maintaining software systems.

DESCRIPTION: Case attempts to cover the complete software life cycle by providing automated support for requirements analysis, specification, design, implementation, maintenance, reverse engineering, quality assurance, project management and documentation. While current CASE products have demonstrated the potential for some automation of the entire software development process, considerably more needs to be done to effectively exploit the potential of CASE -- especially for complex

real time embedded computer software. Innovative ideas are sought in important technology areas that can contribute to CASE, including (but not limited to) development methods, CASE infrastructure, CASE repository, tool integration, user interface, AI (Expert Systems and Neural Nets), executable specifications, prototyping, and performance engineering.

Technologies that can help CASE products reach their full potential (i.e. automate as much as possible the entire software development process) are sought. While investigations may proceed within the context of a particular CASE tool, it is desirable for that technology to be applicable across a wide spectrum of CASE products.

Phase I: Investigate innovative approaches that will lead to significant automation of the software development process and determine the feasibility.

Phase II: If feasibility is shown, develop a prototype system which demonstrates the utility of the approach.

N91-182 TITLE: Simultaneous Focusing Multi-Spectral Infrared Detectors

CATEGORY: Exploratory Development

OBJECTIVE: The design and fabrication of multi-spectral response infrared detectors with common optical areas.

DESCRIPTION: Infrared detectors have wide applications in missile guidance, surveillance, and smart munitions. Their advantage over other sensor types is that they are passive and less susceptible to counter measures. Within the infrared spectrum, multicolor detection is highly desirable; as it can offer clutter rejection, target discrimination and background elimination capabilities through signal processing schemes. Current multi-color detector technologies require the placement of detectors on separate, though contiguous areas of a common substrate. Incoming signal is not fully utilized since the effective area of each detector is reduced.

This solicitation calls for a scheme in which the optical areas of the "colored" detectors are coincident so that the incoming optical beam focuses simultaneously on all of them. The detectors should preferrably be photovoltaic, semiconductors photon counters. Advances in modern technologies for the growth of multi-layer heteroeptaxies involved semiconductors and insulators should be incorporated. Semiconductor bandgap engineering concepts and practices should also be elements of the detector design. Direct bandgap materials of the II-V, the II-VI, and the IV-VI family are appropriate.

Phase I: Conceptualization of the detector structure. Feasibility studies should be carried out. Prototype demonstration is highly desirable.

Phase II: Design, fabrication, and characterization of actual detectors. Performance standards should also be established. Demonstration of two-dimensional, two color, small element array should be included.

N91-183 TITLE: Automated Die Bond Inspection System

CATEGORY: Advanced Development

OBJECTIVE: Study the feasibility and implement a design for an automated system that will inspect die bonds and other parameters on miniature electronic systems such as the Underwater Digital Signal Processor (UDSP).

DESCRIPTION: Introduction and purpose - Manual inspection on miniature computer systems with hundreds of die bonds is time consuming, expensive and subject to human error. Automated robotic vision systems have developed to a state where many inspection steps could be automated, saving time and money and increasing the quality of the hardware.

Phase I: A study would investigate the feasibility of an automated robotic vision system specifically designed to inspect die bonds, chip placement and orientation, and even die wire connectivity on miniature computer systems. Several approaches would be compared and the most promising would be used for a preliminary design.

Phase II: Prototype of the automated inspection system outlined in Phase I would be designed and built using the most advanced technology available. Deliverables would include a complete design analysis, a design documentation package, and a prototype suitable for test and evaluation, using several UDSP furnished by the Navy. The contractor will participate in the test and evaluation tests to guarantee the system is working at full capability and provide timely modifications as needed to optimize system performance.

N91-184 TITLE: Prototype AAW Data Fusion and Command Support System (PADCS)

CATEGORY: Exploratory Development

OBJECTIVE: The development of a prototype control system to aid the embarked Anti-Air Warfare Commander in Aegis air defense functions.

DESCRIPTION: The need for a system to assimilate new sources of offboard/SCI information, merge them with currently available organic assets, and use the information to provide decision support. The system will perform functions of data input, track management, decision support and tactical display. The offboard sources will be analyzed in real time to identify I&W or other alerts. A tract management function will merge the contract data into a track database, provide amplifying information from intelligence databases, do ELINT processing as needed, and perform other contact/track management functions. The tactical display function will provide a continuous and easily assimilable presentation of the AAW situation. A composite AAW Decision Support Sub-system (ADSS) will include tools to assist command in asset management, battle monitoring and assessment, sensor management, communication assessment, cover and deception effectiveness, screen/formation assessment, readiness assessment and replenishment planning, as well as detailed I&W. The system will function, for the most part, at the GENSER level.

Phase I will produce a detailed Type A or similar document describing functionality of the system. In addition, a demonstrable prototype of at least some of the functions should be provided.

Phase II will produce a full scale prototype suitable for laboratory demonstrations. At least some of the functionality should be able to be demonstrated in an at-sea exercise.

N91-185 TITLE: Data Processing and Interpretation of ECM/ESM Contacts

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system that will (1) process remote and local (OTH/organic) ECM and ESM reports, and (2) provide tactically significant information to a platform or mission commander.

DESCRIPTION: ECM/ESM reports contain a large amount of potentially important data, but not in a form that is readily usable by a tactical commander. Individual reports are best processed and assessed within the context of previous reports, the current tactical situation and intelligence databases. Processing would encompass (1) contact/tract correlation using (for example) hypothesis methods, (2) database management of received and internally generated data and (3) issuance of queries to intelligence databases for supporting information.

Tactical assessments would call upon sub-modules that would (for example) perform pattern matching based on historic activity, analysis of current activity trends, development of hypotheses based on known or suspected capabilities, and prediction of future events and deployment of assets to either detect or counter such events.

The need is for a system that will accept reports and perform such processing and assessments in a semi-automatic mode of operation. The informat. .n provided to the user would include alerts, early earnings, current and predicted situation status, asset deployment or similar information. The information would be provided in an assimilable format for the tactical commander to support the decision making process and provide targeting data. The human interface capability would provide detailed background and supporting information as requested by the user and support "what if?" type of queries.

The Phase I product will be, at a minimum, a full description of the algorithms and design to be used. Preferably, a working prototype will be produced demonstrating at least some of the significant functionality.

In Phase II, a working prototype will be produced with all of the functionality needed for a comprehensive field evaluation.

N91-186 TITLE: Development of High Power Microwave Technology for Microsecond Pulses

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this research is to develop new and innovative technology for high power microwave production for microsecond pulselengths and to carry out an experimental demonstration.

DESCRIPTION: High power microwave production using electron beam accelerators has typically been limited by the accelerator pulse length. Currently a new type of intense relativistic electron beam accelerator capable of producing microsecond pulselengths has been developed and is in operation. This accelerator located at NSWC can produce a microsecond long, 3 MeV, 1 kA electron beam pulse. The objective of this work is to develop technology to produce microsecond long high power microwave pulses and demonstrate it using this electron beam. The successful offeror must decide on a concept which is based on an application of these high power microwaves which is of interest to the Navy, such as electronic warfare, missile defense, radar, communications, or some other proposed application.

In Phase I of this work, the concept will be refined using fully electromagnetic particle in cell computer simulations with the parameters of the electron beam mentioned above. By using proper scaling laws, these simulations should be extended to the eventual parameters. A complete set of drawings for the high power microwave tube should be produced to be

used with the NSWC accelerator. A complete description of appropriate diagnostics for this experiment should be produced. These diagnostics should be able to verify the proper operation of the tube.

In Phase II of this work, the microwave tube should be produced and tested on the NSWC accelerator in cooperation with Navy scientists. The proper diagnostics package must be procured. In this Phase, the electron beam will need to be extracted into the tube, and the diagnostics must be used to verify the operation of the tube. The contractor will have to develop an experimental task plan and coordinate this work with Navy scientists.

NAVAL AIR DEPOT/ NORTH ISLAND

N91-187 TITLE: Superconducting Josephson Array

CATEGORY: Advanced Development

OBJECTIVE: To develop a 10-volt superconducting voltage standard referenced to time and frequency

DESCRIPTION: The 10-volt Josephson Array is a superconducting chip that acts like a frequency to voltage converter. The accuracy of the output voltage depends upon how well you can measure the input frequency. Since frequency is the most accurate measurement known to man, the application of the Josephson Array allows the use of DC volts to achieve equal or more accurate frequency measurements compared to current methods.

The DC voltage measurement is the basis for most other electrical parameters, i.e. AC volts, current, capacitance, and resistance. An increase in the ability to accurately measure DC volts will cause increased accuracies of varying proportions in the other measurement areas as well.

A prototype 10-volt junction is presently operating at the Navy Primary Standards Laboratory at North Island. The work described in phases I and II is needed so that this technology becomes the routine method for DC voltage traceability in the Navy Metrology Program.

Phase I will be a study addressing the items listed below:

1. Identify critical components, provide redundancy and increased reliability to reduce down time.
2. Improve the error analysis routines in the system software.
3. Improve the capability to produce reliable 1- and 10-volt arrays, and transfer this technology to private industry.
4. Increase the operating temperature of the device for 4 degrees K to around 77 degrees K, or simplify the logistics and technical problems encountered when operating at 4 degrees K.

Phase II will be a conceptual development effort. It will target the most difficult technical problems identified in Phase I and develop breadboards or working models to demonstrate that these problems can be overcome.

N91-188 TITLE: Centrifugal Filtration of Corrosive Process Solutions

CATEGORY: Engineering Development

OBJECTIVE: To develop the technology and equipment to centrifugally filter corrosive process solutions used at aircraft maintenance activities. If successful, this technology would extend process solution lives by extracting harmful particulates, sludges and residues.

DESCRIPTION: Historically, large volume process solutions are prematurely dumped due to contamination build-ups that cannot be simply filtered out. The high temperatures and corrosive nature of these solutions preclude the use of standard filtration methods. Centrifugal filters are dynamic devices that spin out the contaminants from the solution. The cleaned solution is returned to the process tank and the separated hazardous waste is drawn off into disposal drums. Conservative estimates show that removal of contaminants from alkaline cleaning solutions and electroplating baths can at least double and in many cases quadruple solution life. For example, a 1600 gallon tank of a highly concentrated, chelated alkaline scale conditioner costs over $22,000 to make up and over $2,500 to dispose of it twice a year. Although the existing centrifugal filters work well on fairly neutral, benign solutions, the technology has not been demonstrated on high temperature corrosive solutions.

Phase I should consist of a study outlining the approach which will be undertaken to achieve the technology required to develop the centrifugal filter designs for all high temperature corrosive process solutions identified by the preparing activity.

Phase II should utilize technology developed in Phase I to actually build and deliver to the government a high capacity, efficient corrosive solution centrifugal filter system that is skid or wheel mounted for portability. The government will test the filter on the variety of corrosive solutions that was identified in Phase I.

NAVAL AIR DEPOT/NORFOLK

N91-189 TITLE: Advanced Aircraft Wire Marking Systems

CATEGORY: Advanced Development

OBJECTIVE: To identify advanced technologies which could be used to permanently identify aircraft electrical system wires.

DESCRIPTION: Currently automated Ink Jet and Nd:YAG Laser systems are being used to mark aircraft electrical wiring with identification information prior to incorporation into aircraft wire harnesses. Both systems have problems associated with them which could be eliminated with the use of an advanced technology. Wire identification is in the form of alphanumeric characters and bar codes. The information is placed on wire outer insulation coatings every three inches. Current Ink Jet wire markers can cause smeared markings and fade over a period of time causing problems in reading the markings. Nd:YAG Laser systems have problems with control of heat input. Too much heat input causes burning and scorching of the insulation and damage to the wire core. ND:YAG Laser marking has not been approved for use by the Navy on aircraft wiring.

Phase I should consist of a study identifying advanced technologies which could be applied to legibly marking aircraft wires without damage to the insulation and wire core. The advanced technologies identified should be technologies that have been proven reliable and could be integrated into an automated production environment. Test data supporting the study should be included. The most promising technologies should be identified and ranked according to feasibility. Nd:YAG Lasers and Hot Stamp should not be studied.

Phase II should provide an automated system which can be integrated into an automated aircraft wire manufacturing facility for testing.

NAVAL AIR DEVELOPMENT CENTER

N91-190 TITLE: Miniature Radio Frequency (RF) Decoy Thermal Battery

CATEGORY: Advanced Development

OBJECTIVE: Increase the reliability of the present miniature RF decoy's thermal battery while maintaining present power density and outputs.

DESCRIPTION: Currently miniature RF decoys are powered by short duration thermal batteries which provide multiple voltages with short initiation times. Durations are measured in seconds and initiation in msec. Critical performance requirements strain power density constraints which can lead to a possible short-circuit which is unsatisfactory. This effort will be directed at increasing the reliability/reproducibility of thermal batteries.

Phase I will require the contractor to deliver designs for a higher reliability battery for the GEN-X (Generic Expendable Decoy).

Phase II will require the contractor to deliver a prototype battery to be installed for testing with the GEN-X. Selected contractor must have personnel and facility clearance of Secret during Phase II. Drawings and specifications are available by contacting the SBIR office.

N91-191 TITLE: Optical Neuron

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the possibility of developing an optical neuron on a chip.

DESCRIPTION: Neural networks have the potential to provide adaptation to changing or uncertain dynamic characteristics of high performing aerospace vehicles and ever-improving performance through dynamic learning. An optical neuron would provide the neural network with inherent electromagnetic immunity.

Phase I: Develop and design an optical neuron on a chip.

Phase II: Fabricate the neuron and test it. Some of the necessary technologies for this task will be:

..on-chip optical waveguides

..passive optical multiplexing

..passive optical threshold detection

..optical summation with optically variable gains on each input

N91-192 TITLE: Tactical/Operator Aids

CATEGORY: Advanced Development

OBJECTIVE: To identify and develop tactical and operator decision aids to enable effective S-3B integration and utilization of the new active sonobuoy, the Air Deployable Active Receiver (ADAR), and Expendable, Reliable Acoustic Path Sonobuoy (ERAPS).

DESCRIPTION: Tactical decision aids are not currently available to assist the operator in tactical planning for optimum buoy deployment and depth selection. Also, operator aids do not exist for classification and tracking of active acoustic contacts/detections. The purpose of this project is to develop tactical decision aids to assist S-3B operators in the tactical planning for optimum deployment of ERAPS and ADAR sonobuoys, and to develop operator aids for effective classification and tracking of active acoustic detections.

Phase I: Study to define feasible approaches to providing operator aids as a part of S-3B tactical mission program software.

Phase II: Develop rapid prototype software to implement the most feasible, practicable approach identified during Phase I.

N91-193 TITLE: Complex Radar Target Signature Augmentation

CATEGORY: Advanced Development

OBJECTIVE: Provide radar target capability to replicate the following threat characteristics: scintillation, glint, jet engine modulation (JEM), polarization.

DESCRIPTION: Expendable radar targets used in weapon test and evaluation or proficiency training vary in their capability to replicate threat characteristics for accurate assessment of engagement end games, complex radar signature simulations are required. Digital RF memory technology is particularly applicable to high fidelity simulations of this nature. Features for target augmentation include scintillation, lint, JEM, and polarization components as a minimum.

Phase I: Should focus upon requirements determination of a technical approach and draft specification. Delivery: Specification.

Phase II: Fabricate a brassboard prototype suitable for integration on an aircraft for concept demonstration and test. Delivery: Prototype hardware.

N91-194 TITLE: Small Baseline Vector Scoring

CATEGORY: Advanced Development

OBJECTIVE: Provide accurate non-cooperative vector scoring from target platforms offering small baseline dimensions.

DESCRIPTION: Current vector scoring approaches rely upon trilateration techniques which require large dimensions (baselines) between antennas in order to achieve acceptable accuracy. However, a requirement exists to provide small scale targets as well as very high speed with vector scoring capability. In neither case is a large enough baseline available to satisfy the demands of current scoring systems.

With the advent of recent digital processing techniques applied to general non-cooperative scoring problem, it now appears possible to employ measurement techniques based upon radar return from several antenna elements spanning very small baselines. The development of this technology is expected to handle even such extreme cases as equipping missiles with vector scoring capability.

Phase I: Study to determine alternate methods of achieving vector scoring data from small baseline targets. Delivery: Study.

Phase II: Construction of a feasibility model of a vector system. Delivery: Prototype hardware.

N91-195 TITLE: Data Compression Applied to Doppler Scoring Signals

CATEGORY: Engineering Development

OBJECTIVE: Telemeter several wideband Doppler signals produced by multi-antenna scoring systems through a narrow band telemetry channel.

DESCRIPTION: As the requirement for more complex airborne measurement systems increases, it is apparent that the amount of Doppler information produced increases in direct proportion. As this increased amount of data requires transmission to the ground, wider telemetry bandwidths are required. Due to high usage it is increasingly difficult to obtain wide bandwidth allocations. If this situation is not addressed, the capability of future airborne systems might well be limited by simple telemetry channel capacity. Fortunately, there is a great deal of redundancy in the Doppler signal generated by the passing projectile which makes such signals natural candidates for various types of data compression techniques. Due to the unique chirp and statistically non-stationary nature of these Doppler signals, conventional data compression techniques will have to be substantially modified to be effective. Compression techniques must be developed to function in the very low signal to noise ratio environment that is characteristic of scoring Doppler signals and through a telemetry channel experiencing frequent data dropouts.

Phase I: Investigation and trade-off of various methods of compressing large amounts of Doppler data into narrow telemetry bandwidths. Delivery: Study.

Phase II: Develop working algorithms and prototype hardware to prove feasibility. Delivery: Prototype hardware with software.

N91-196 TITLE: Three Dimensional Radar Imaging for Scoring Applications

CATEGORY: Engineering Development

OBJECTIVE: Develop three dimensional radar images of missiles passing a suitably equipped airborne target thus providing missile identification and orientation information.

DESCRIPTION: A great deal of progress has been made in the area of Doppler signal processing with broad application to scalar and vector missile scoring. These techniques appear to have promise in the area of three dimensional radar imaging of objects passing near a drone target aircraft equipped with a multi-antenna vector-type radar sensor. The resulting radar image will be a quasi-optical three dimensional rendition of the projectile at a predetermined position in its trajectory within the neighborhood of the target aircraft. Major features such as control surfaces, nose, tail, and other abrupt discontinuities are expected to be visible. Since the image will be constructed in a coordinate (x,y,z) system referenced to the target aircraft, it will reveal attitude of a missile with respect to the target.

Phase I: Demonstrate the imaging capability using simulated Doppler data. It will be necessary to determine what type of display device would be suitable to present such an image to the user. Delivery: Demonstration.

Phase II: Perfect the algorithm to operate in a timely and automatic fashion. The results of the process will then be interfaced to the selected three dimensional display device. The entire system will be extensively tested using flight test data gathered on a suitable Doppler scoring radar. Delivery: Prototype hardware with software.

N91-197 TITLE: Reconfigurable Infrared Detector Assembly for Dual Function Optical Scanner

CATEGORY: Advanced Development

OBJECTIVE: To develop passive electro-optical sensor for air ASW and surveillance.

DESCRIPTION: The Navy's infrared imaging equipment provides moderate to high spatial resolution of scenes and targets at low to moderate thermal sensitivity. However, some naval applications such as tactical oceanography. and ASW require very high thermal sensitivities. Accordingly, new infrared line scan imaging equipment is needed to provide, simultaneously, high spatial resolution of targets and high thermal resolution of the scene. Critical components needed for such a device are dual function optical scanner and electronically reconfigurable detector assembly. Such devices and components are not currently available. In FY-90, the DON's SBIR Topic entitled "Dual Function Optical Scanner" (Topic No. N90-371) will lead to the development of the dual function optical scanner. This effort will develop an infrared detector assembly to convert the infrared radiation from the Dual Function Optical Scanner into both a high resolution mode and a high sensitivity (order-of-magnitude increase over existing sensors) mode video simultaneously. Some key characteristics of the detector assembly are: (a) Mercury Cadmium Telleride detector array (8-12 um infrared band) electronically reconfigurable for high resolution or high sensitivity, (b) close cycle cryogenic cooler (77 K) and dewar assembly, (c) preamps and circuitry for signal conditioning, digital scan conversion, and generation of dual mode (i.e. high resolution and high sensitivity) video output.

Phase I: Design the complete detector assembly.

Phase II: Proceed upon approval of the Phase I design package. The detector assembly will be fabricated from the design package developed in Phase I.

N91-198 TITLE: Synthetic Generation of Dynamic Infrared Scenes

CATEGORY: Advanced Development

OBJECTIVE: To develop model based synthetic infrared scenes for sensor prediction and mission planning.

DESCRIPTION: The need exists in the Navy and Special Warfare missions to accurately simulate the target scene areas as seen through the actual infrared sensors (e.g. Forward Looking Infrared (FLIR), and Infrared Linescanner (IRLS) through the corresponding displays aboard the mission aircraft. The requirements of this effort are: (a) develop end-to-end model based image train analysis software and sensor performance prediction (i.e. linking target and background characteristics, atmospheric models, platform stability, sensor parameters, and display characteristics), and (b) generate dynamic background scenes and the ability to super-impose a variety of moving targets (e.g. tanks, trucks, boats, aircraft, etc.) on selected backgrounds as seen by the infrared sensors aboard the mission aircraft. Sample digital imageries of selected backgrounds and targets will be provided by the government in ATRWG formats.

Phase I: Design the algorithms along with the Program Performance Specification (PPS) for Sun 4 image processing work station.

Phase II will follow upon the approval of Phase I design and definition and will include the PPS software implementation.

N91-199 TITLE: Optical Film Reader and Digital Image Processor

CATEGORY: Advanced Development

OBJECTIVE: To develop a low cost optical film reader and digitizer to enhance film processing capability aboard naval platforms.

DESCRIPTION: The Navy uses large quantities of film for recording everything from photographic and sensor reconnaissance imagery to high speed scientific data recording. Most film readers and imagery analyzers are large cumbersome light tables and processors used to observe and convert the imagery to electronic data. In many applications the imagery must be processed and stored in digital format for further processing and usage. Some do not preserve geometric fidelity and scale because of distortion in devices that convert the imagery to electronic data. This film reader and digitizer shall attempt too reduce this operation to an all electronic system about the size of a low cost electronic workstation. The unit shall contain a film transport, optical reader, digitizer, image-processing computer workstation, and high resolution monitor. Some of the key characteristic for the reader/digitizer include: Ability to handle a large variety of film formats from 35 mm to 9 inch cut film and roll film 10 to 2000 ft.; Resolution of 250 lines/inch at 1X magnification up to 5,000 lines/inch at 10X magnification; field-of-view 5 X 5 inches at 1X; magnification continuously variable or at least 5 discrete points; transport speed 0 to 10"/sec. with a fast wind or rewind speed; digitization to 12 bits with ability to reduce down to 6 bits. Large magnetic or optical storage > = 600 Megabits for playback storage; analog and digital output; a 17 inch 1280 X 1024 monitor.

Phase I: Study would include design of the work of the reader digitizer and required components.

Phase II: The sample reader and digitizing processor including required hardware and software would be fabricated from the design package developed in Phase I.

N91-200 TITLE: Off-board Electronic Countermeasures (ECM) for Subscale Targets

CATEGORY: Advanced Development

OBJECTIVE: To provide subscale target vehicles such as the BQM-74C with a capability to decoy approaching RF guided missiles. Such a capability would provide more realistic ECM environment for weapons evaluation and for fleet training, and serve to reduce target vehicle losses during these exercises.

DESCRIPTION: Certain types of RF guided missiles are relatively immune to on-board jamming systems. Decoys dispensed or towed behind the aircraft are required to seduce the missile during its terminal phase of flight. While this need is being satisfied for full-scale targets through current manned aircraft developments, it remains an unfulfilled requirement for the smaller sub-scale targets due to size and power constraints. A small towable decoy needs to be developed for this application.

Phase I: Preliminary design and layout of the decoy utilizing Monolithic Microwave Integrated Circuits (MMIC) and Very High Speed Integrated Circuits (VHSIC) technology for miniaturization. Antenna, transmit/receive isolation, electronic payload, power, and software requirements as well as towline/towbody dynamics will be addressed during this phase. Delivery: Design documentation.

Phase II: Final design and fabrication of the Phase I concept will produce a flyable prototype for evaluation Delivery: Prototype hardware.

N91-201 TITLE: Compliant Non-Aerosol Topcoat

CATEGORY: Exploratory Development

OBJECTIVE: To develop an exterior paint that complies with air-pollution regulations and can be applied from a non-aerosol container for aircraft and equipment touch-up by fleet personnel.

DESCRIPTION: Phase I: The contractor shall demonstrate that a clear, one-component topcoat formulated with the binder under development can be sprayed from a non-aerosol container to a smooth, uniform film. The maximum concentration of volatile organic compounds shall be 340 grams/liter; and the applied film shall meet the performance requirements of specification MIL-L-81352.

Phase II: The contractor shall develop pigmented formulations, evaluate their physical and chemical properties, arrange for service tests by fleet personnel, and prepare a draft specification.

NAVAL UNDERWATER SYSTEMS CENTER

N91-202 TITLE: Combined Combat System Models

CATEGORY: Advanced Development

OBJECTIVE: To develop a single analytical model of complex electronic systems. The model is intended to evaluate concurrently the tactical performance, reliability, maintainability, and life-cycle cost.

DESCRIPTION: Performance, reliability, maintainability and life cycle cost are complementary in system design but there is no model that effectively manages the tradeoffs that must be made among them. There are computer models for estimating the tactical performance of combat systems in the face of a postulated threat. There are other models for evaluating the reliability, maintainability, availability and repair parts requirements of various system architectures. Similarly, there are models that estimate the cost of development, testing, installation and life-cycle support. All these models are unique and independent of each other. Procurement of complex electronic systems must consider all these interrelated and often conflicting factors simultaneously. Linking the outputs of these models is now done subjectively, if at all. What is required for effective combat procurement is a single model that combines performance, RMA, and cost considerations so that optimum integrated decisions can be made.

Phase I: Evaluate existing models that estimate performance, RMA and life-cycle cost. The feasibility of modifying these models to have system performance reflect RMA and life-cycle cost should be estimated. Techniques for combining the available models or rationale for the development of a new model, or combining shell, should be presented along with estimates of computational power required and an estimate of the model's accuracy and efficacy.

Phase II: Develop a working model that combines at least tactical performance, RMA, and life-cycle cost.

N91-203 TITLE: Shape Memory Alloy Materials Development for Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Develop shape memory alloys with properties, stock sizes and configurations which are not currently available.

DESCRIPTION: The Navy is currently developing quiet self contained actuator technology which utilizes shape memory alloy materials. At present the Navy is using a nitinol (Ni-Ti) alloy which is available as wires with diameters of 0.003-0.010 inch (0.08-0.25 mm). Future applications of this technology are limited by the load capacity, the life cycle duration, and the cycle frequency of these wires. The cycle frequency is primarily limited by cooling rate. To mitigate these limitations, the Navy is interested in the development of shape memory alloy materials with any or all of the following properties:

- Alloys which transition from austenite to martensite and back to austenite over a narrow temperature range (as low as 1°C).

- Alloys which transition at high temperatures (up 150°C).
- Alloys with life cycles of 10-100 million cycles without degradation of performance and strength.
- Alloys with working strengths up to or exceeding 40,000 psi.
- Wire stock with diameters up to 0.1 inch (2.5 mm).
- Stock in other configurations with large surface to volume ratios such as foil, flat stock, or wire rope.

N91-204 TITLE: Submarine Electronic System Power Supply

CATEGORY: Exploratory Development

OBJECTIVE: Develop new methods for supplying power to submarine electronic systems that are not affected by the loss of one AC buss.

DESCRIPTION: Submarine electronics get their motive power from the ship's power distribution system. The deletion of 400 Hz power generation equipment and the unavailability of DC for electronic service make all current and future systems rely on 60 Hz sources. The submarine AC power distribution system is split between port and starboard and offers reliable power if the electronic system can accept interruptions caused by switching from one (failed) side to the other (operating) side. Existing systems cannot always accept the fault. There is no room in electronic cabinets for sufficient energy storage to carry through the interruption. Generation and distribution of auctioneered DC has been attempted and presents substantial difficulties in terms of weight, volume, cooling, electrical stability, electromagnetic noise, and reliability. New methods of power supply are required to support combat system electronic systems.

Phase I: Offer a method of power supply that is not affected by the loss of one AC source bus. Power availability, small size, and low conducted and radiated emissions are important considerations that must be estimated for the proposed power supply method. Electrical performance shall be quantified with brass board demonstration results

Phase II: Scale up the concept to hardware with a capacity of approximately 10 kw-hr

N91-205 TITLE: Workstation Architecture for Submarine Combat Systems

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate the costs, benefits, and implementation implications of a combat system architecture based on the computerized workstation.

DESCRIPTION: Phase I: Submarine combat systems have used a central main-frame computer and terminal like display units. Systems under development have been placing less reliance on the central computer by placing processors of various capacity in the display units to support processing remote from the central elements of the system. The central processors support data management and system control. Connections between the central processor and the displays have been variously dedicated, redundant, and cross-strapped. The quantifiably optimal system architecture is required for future systems. These systems have wide variations in operability, modifiability, testability, reliability, and availability architecture model that satisfies the performance requirements for submarine combat systems. The model required must include attributes with variability to demonstrate the sensitivity of the architecture to the degree of centralism, workstation processing capacity, redundancy of interconnections, complexity of development, difficulty of testing, and cost.

Phase II: Identify the adjustments to the existing combat systems required to attain the benefits of the optimum architecture.

NAVAL AIR ENGINEERING CENTER

N91-206 TITLE: Arresting Cables Network

CATEGORY: Advanced Development

OBJECTIVE: To utilize all four of the current arresting engines during arrestment. If successful, then each individual current arresting engines would not be worked to its limit. This would improve the life and efficiency of each arresting engine. The entire arresting capability could almost increase by four fold.

DESCRIPTION: Arresting cables network would connect all four of the pennant cables via grid like structure. There would be four (or more) of these network cables and they would run perpendicular to the pennant cables. The aircraft arresting hook will hit one of the pennant cables, which in turn would pull on the network cables. This in turn would pull on the other three awaiting pennant cables. All four of the arresting engines are now utilized.

Phase I should consist of cable and geometry studies, and the effect of cable friction, this includes how the network cables are to be attached to the pennant cables and which different cable materials are best suited. With sufficient data collected, feasibility could be demonstrated.

Phase II should produce a working product of the network cables, scaled down if necessary, delivered to the Navy for testing. If any alternations are made to the pennant cables, the modified pennant cables are also to be delivered to the Navy for testing.

N91-207 TITLE: Feedback System for Weapons Loaders

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system which can potentially be retrofitted to existing and proposed weapons loaders (installation/removal equipment). The system would provide "real-time: feedback of weight being lifted and proximity of load to the aircraft.

DESCRIPTION: Weapon and store loading onto Navy and USMC aircraft is currently performed with a wide variety of armament support equipment including: manual bomb hoists, powered bomb hoists, weapons loading trailers, non-propelled weapons loaders and powered weapons loaders.

Hoist loading equipment generally is more advantageous since the lifting of the load is controlled with respect to the aircraft. "Push-up" weapon loading equipment generally suffers from the inability of the equipment or operator to automatically compensate for finite adjustment and/or may damage the various aircraft. Due to the severity of the sea states encountered by the ships on which they are deployed, aircraft movement can occur during the loading task. Some aircraft have WRA's which are bolted to the airframe and require precise movements of the installation/removal device. "Push-up" loaders may require multiple personnel to guide the installation of stores onto/into aircraft. The current propelled "push-up: USMC A/S32K-1 and Navy AERO 47 Weapon Loaders do not have a feedback system. The current nonpropelled "push-up" Navy ADU-400, AERO 33, MK 7 Weapon Loaders do not have feedback systems.

Phase I: 1) Survey existing sensor systems available "off-the-shelf" and new systems "in-work", 2) Research reports generated by various government activities and commercial vendors, 3) Conceptualize systems that can be adapted to nonpropelled and propelled weapon loaders.

Phase II: Build a breadboard system that can be adapted to the aforementioned loaders.

N91-208 TITLE: Automated Repairman or Autonomous Repair/Rescue Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To provide automatic repair/rescue service needed for disabled autonomous vehicles performing aviation support services aboard ships.

DESCRIPTION: The Navy is contemplating the utilization of autonomous vehicles to perform seaboard aviation support functions. In line with these advanced concepts, an autonomous repair/rescue vehicle is envisioned to be necessary to offer "emergency" repair services to any aviation support vehicle that might become disabled. The purpose of this effort is, therefore, to determine the feasibility and establish the requirements for such a repair/rescue vehicle.

Phase I: Determine the feasibility.

Phase II: Produce repairman or autonomous repair/rescue vehicle.

N91-209 TITLE: Advanced Materials for Wire Rope Construction

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the use of ion implantation on wires and alternate rope core materials to extend loading capacity and service life of existing arresting gear cables. If successful, this technology would also be applicable to other wire rope industries.

DESCRIPTION: Today's best high strength wire rope is constructed with extra improved plow steel. This materials is unsurpassed for its combination of strength, ductility, wear resistance and fatigue behavior. The only avenue for improving this wire material is to enhance its resistance to wear and fatigue with a surface coating. Ion implantation is a new and expanding technology which is capable of altering the surface chemistry of high strength engineering materials. It is a unique process in that elements are actually implanted in the material so disbonding is impossible. The process can also be accomplished at near room temperature which will not degrade the wires mechanical properties.

Phase I would consist of feasibility studies to examine the probability of applying elements to wire surfaces by ion implantation to increase fatigue and wear resistance. Single wires will be ion implanted and laboratory tested. The evaluation will entail tests for bending fatigue, abrasion resistance and susceptibility to notching from contact with other wires as well as the routine mechanical properties (UTS, YS, %E, %RA). All tests will include a sample of untreated wire. Increased performance of treated to untreated wires will be an evaluation factor for Phase II.

Phase II would require the construction of actual wire rope samples. This will involve adapting existing ion implantation equipment to treat several spools of extra improved plow steel needed to produce a reel of arresting gear cable. For evaluation purposes the existing construction of purchase cables shall be used for testing. Several samples shall be made with a hemp core. Alternate core materials shall also be included for testing. These samples will be tensile tested and tested in a sheave cycle tester for fatigue life and wear resistance as compared to the existing construction.

NAVAL CIVIL ENGINEERING LABORATORY

N91-210 TITLE: Energy-Absorbing Ship Mooring Configurations

CATEGORY: Exploratory Development

OBJECTIVE: Develop and validate new hardware and configurations to provide energy absorption for shallow water ship moorings. This proposed task is to investigate alternative mooring configurations and hardware to maximize the amount of energy absorption in Navy moorings, especially for moorings in shallow water and/or hard bottom materials (e.g., rock, coral).

DESCRIPTION: It is common for moored ships to exhibit oscillatory behavior at single point moorings. This behavior, referred to as "fishtailing," or, "kiting," results in very large hawser tensions as the mooring system restrains the vessel at each end of its swinging. In many moorings, particularly shallow water moorings, this is a serious problem, because the mooring system does not have a large reserve of geometric or material stiffness to absorb these tension spikes. Failure of either the mooring system or the vessel bow structure is not uncommon in these cases. If the mooring system fails, there is the potential for both the loss of the vessel (and its contents) and for environmental damage. On the other hand, if the mooring system capacity is too high, the failure will occur at the bow of the vessel; this possibility is increasing because of the recent trends to trade-off structural weight on combatants to maximize the weapons-related weight. This type of failure results in lost operational time and costs due to shipyard repairs. New moorings are required that will absorb these large tension spikes and therefore minimize the chance for system failures.

Phase I: Refine the new alternative mooring concept(s) submitted in the SBIR proposal; contrast the energy absorption characteristics and advantages of the new concept(s) versus presently used Navy and commercial mooring configurations; and recommend a small-scale testing program for Phase II to validate the concept(s). This test plan shall include the mooring configurations and site conditions selected for testing, and an outline of the recommended tests including the purposes for each. The Phase I report shall also include a summary of the findings regarding their expected impact on existing mooring operations (e.g., failures) and design (more efficient use of materials).

Phase II: Model-scale tests to validate the behavior of the proposed mooring concept(s). Multiple configurations, site conditions, vessels, and excitations shall be tested and their characteristics reported. The final Phase II report shall summarize the research, and present recommended configurations for further Navy consideration.

NAVAL AIR PROPULSION CENTER

N91-211 TITLE: Non-Intrusive Fuel Flow Measurement System

CATEGORY: Exploratory Development

OBJECTIVE: To assess the current state-of-the-art and develop fuel flow measurement techniques which produce high accuracy fuel flow measurements with zero pressure loss.

DESCRIPTION: The Navy wishes to investigate non-intrusive fuel flow measurement techniques which produce a zero pressure drop across a device while providing high accuracies. Current devices generate pressure drops which interfere with normal engine/fuel system performance. Our requirements are for a device which measures various aircraft fuels with viscosities ranging from 0.4 to 12 centistokes within the limiting fuel temperature range of -60 to +160 degrees f. Accuracies of +/- 1.0% Of reading or less are desired. The techniques should be capable of being incorporated into a device capable of a flow turndown ratio of at least 50 to 1. The flow operating ranges should be suitable for aircraft propulsion systems (small unmanned aerial vehicles to tactical aircraft).

It is anticipated that investigation into candidate fuel flow measurement concepts would be divided into two phases. First, conceptual designs would be generated and validated through theory and analytical assessment and/or testing. Second, based on successful results of the first phase, fabrication of proof of concept designs and experimental verification of the approach would be made.

N91-212 TITLE: Innovative (UAV) Unmanned Aerial Vehicles VTOL (Vertical Takeoff and Landing) Propulsion Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Develop VTOL propulsion concepts which provide optimum propulsion efficiency throughout the UAV regime.

DESCRIPTION: Operation of unmanned aerial vehicles (UAV's) from small naval ships requires vertical takeoff and landing (VTOL) capability because of limited deck space and large operating radius because of the long engagement distances of modern weapons. Current state of the art in VTOL propulsion yields either good vertical takeoff performance with poor high speed flight characteristics or good high speed flight characteristics with excessive power requirements for vertical takeoff. Innovative concepts are desired which would provide a lightweight propulsion system with high propulsion efficiency (thrust specific fuel consumption) throughout the 0 to 200 knot flight regime.

It is anticipated that investigation into candidate concepts would be divided into two phases. First, conceptual designs would be generated and validated through theory and analytical assessment and/or testing. Second, based on successful results of the first phase, fabrication of proof of concept designs and experimental verification of the approach would be made.

N91-213 TITLE: Improved Corrosion Susceptibility Prediction by Real Time Optical Measurement Technology

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this research is the development and construction of a non-intrusive integrated optical system. The system will be capable of measuring the real time sodium mass flux into turbo-shaft jet engine during corrosion susceptibility tests.

DESCRIPTION: Current sodium mass flux measurements are time consuming, laborious and lead to multiple errors such as handling contamination, improper sample analysis, etc. The utilization of state-of-the-art optical technology will eliminate the aforementioned difficulties, increase measurement accuracy and provide a measurement technique which does not interfere with the flow process being measured.

Phase I - The first phase of the proposed research will be a feasibility study. The study will: 1) specify the optical methodology most suited for measurement sodium mass flux; 2) include a detailed description of the methodology; 3) analyze the capabilities of the proposed methodology with the support of analytical data and experimental evidence where possible; 4) discuss the methodology in terms of implementation and 5) describe the development and construction of a "breadboard" prototype instrument (Phase II).

Phase II - The prototype instrument discussed in Phase I will be constructed and tested according to pre-set guidelines. The tests will determine the effectiveness of the proposed methodology under Navy specified conditions. With the validation of the prototype instrument, the development of an instrument capable of withstanding the Navy test environment will be investigated and described.

N91-214 TITLE: Innovative UAV Engine Noise Suppression Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Develop lightweight, low volume noise suppression concepts capable of rendering an unmanned aerial vehicle (UAV) inaudible under tactical operating conditions.

DESCRIPTION: Present UAVs have decreased covert capability and survivability due to the significant aural signature of their internal combustion engines. The purpose of this project is to develop innovative noise suppression concepts capable of operating on 2-stroke, 4-stroke, and Wankel engines.

The concepts should be of minimum weight and volume. They shall be capable of reducing the sound level to less than 60 dB at a distance of 1000 ft throughout the engine RPM and power range. This should be achieved with no more than 2% power loss.

It is anticipated that investigation into candidate concepts would be divided into two phases. The Phase I effort shall include a comparison of proposed conceptual designs to the current state-of-the-art. These designs shall be validated through theory and analytical assessment and/or testing. Based on successful results of the first phase, the Phase II effort shall include fabrication of proof of concept designs and experimental verification of the approach.

N91-215 TITLE: High Speed Diesel Fuel Injection Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To increase the maximum injection rate of diesel-type fuel injectors, thus permitting engine horsepower growth through increased operating RPM.

DESCRIPTION: Advanced lightweight unmanned aerial vehicle (UAV) engines require diesel-type, high pressure direct injection. Current state-of-the-art direct injection is capable of approximately 6000 injections per minute. This limitation inhibits growth of engine horsepower through RPM increase. Innovative concepts are desired which would permit significantly higher injection rates than the current state-of-the-art. It is anticipated that investigation into candidate concepts would be divided into two phases.

Phase I: Conceptual designs would be generated and validated through theory and analytical assessment and/or testing.

Phase II: Based on successful results of the first phase, fabrication of proof-of-concept designs and experimental verification of the approach would be accomplished.

NAVAL AIR TEST CENTER

N91-216 TITLE: Real Time Helicopter Blade Element Tail Rotor Model

CATEGORY: Exploratory Development

OBJECTIVE: Development helicopter blade element tail rotor and tail rotor interference models for use in operational flight trainers. A market exists for these models wherever helicopter pilots are trained using simulators.

DESCRIPTION: Army and Navy helicopters have experienced problems with loss of tail rotor effectiveness under certain slow speed approach-to-landing flight conditions. Current operational flight trainers (OFT) do not have adequate fidelity to predict all low-speed flight conditions leading to loss of tail rotor effectiveness. Pilots are not able to use OFTs to practice recovery from loss of tail rotor effectiveness under controlled conditions. Improved tail rotor models, including flow interference models, are required. The tail rotor model should include effects of main rotor, fuselage, and external stores interference for steady and turbulent ambient winds. The tail rotor model should be developed in modular form for real time applications. It should have a format suitable for incorporation into existing OFTs with blade element main rotor models.

Phase I requires research and summary of the relevant characteristics of existing tail rotor models and tail rotor interference models, and existing technical and operational data on helicopter tail rotor airflow problems at low airspeeds; and specification of the blade element tail rotor model and tail rotor interference models, including the interface with existing main rotor blade element models.

Phase II will require development and installation of the helicopter blade element tail rotor model and associated interference models on a specified simulator, and verification and validation of the models.

N91-217 TITLE: Portable Simulator Evaluation Package

CATEGORY: Engineering Development

OBJECTIVE: Develop a portable simulator evaluation package to speed-up, reduce cost, and help standardize Operational Flight Trainer (OFT) and Weapon Systems Trainer (WST) acceptance testing.

DESCRIPTION: A portable laptop personal computer (PC), with proper interface cards, could be used to record a minimum of 48 channels of either analog or digital data from the simulator. A standardized set of criteria data, plus tolerances, could be stored in the PC using current software packages like MATLAB. The simulator test data could be compared to the stored criteria data in real time or at a later date as required. Simulator data could also be sent via modem to other activities to help confirm the status of simulator development.

Phase I requires definition of PC hardware and OFT/WST interface options for the portable simulator evaluation package and specification for procurement; and definition of software requirements and review of Navy OFT/WST criteria data format and criteria data tolerances.

N91-218 TITLE: Automated Forward Looking Infrared (FLIR) Resolution Measurement

CATEGORY: Engineering Development

OBJECTIVE: A device to read FLIR displays and automatically measure maximum resolution and minimum resolvable temperatures. A large market exists for this capability with developers, producers and users of imaging systems, both military and civilian.

DESCRIPTION: Measuring maximum resolution and minimum resolvable temperature of FLIR systems is labor intensive and subjective. Typically, five persons read the display and their readings are averaged, as persons see differently. A system is needed to automatically read the various sizes and types of displays and measure standard four bar, seven to one aspect ratio targets of varying size and delta temperatures. The measurement capability shall be comparable to the human eye with an accuracy of better than .01 degree Celsius delta temperature. The system should be transportable between laboratory, hangar and flight environments. The system must automatically select different delta temperatures and spatial frequencies once a measurement is made.

Phase I: Requires a conceptual study and specification of the system.

Phase II: Requires the production of a prototype for test at the Naval Air Test Center.

N91-219 TITLE: Test and Evaluation of Tactical Expert Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop the capability to test airborne tactical expert systems by researching current activities in the field, establishing an expert system workstation, and developing test methodologies.

DESCRIPTION: Expert systems are emerging from research laboratories and being applied in a wide range of fields, including defense applications. In particular, the Naval Air Development Center is developing algorithmic decision trees to automatically optimize defensive electronic countermeasures in tactical aircraft such as the F/A-ISC/D. These algorithms, which coordinate on-board and off-board expendables, may form the knowledge base of an expert system. The Naval Air Test Center is tasked with testing such systems. However, methods for test and evaluation of airborne tactical expert systems are not well defined. A need exists at the Naval Air Test Center for increased expertise in this rapidly developing field both in expert systems and their test and evaluation.

Phase I will consist of research into all present activities and active progress in the area of tactical expert systems. Transfer of this information will be via seminars and technical discussions. The technical problems of testing expert systems will be addressed, in particular, the system's limitations, degraded modes, and execution speed. Recommendations will be made of suitable hardware and software to produce a workstation for the test and evaluation of expert systems.

Phase II will develop a computer workstation capable of testing and evaluating tactical expert systems. The workstation will consist of an expert system shell to enable engineers to become familiar with the design and operation. In addition, the workstation will incorporate a testing shell to facilitate evaluation of the expert system.

N91-220 TITLE: Video-Based Data Reduction System for Task Analysis

CATEGORY: Engineering Development

OBJECTIVE: A system to extract and reduce task analysis data from video tape containing multiplexed simultaneous views from several cameras. A market exists for this system with every government agency and military or civilian system developer that is engaged in human factors test and evaluation.

DESCRIPTION: Aircrew actions during flight and ground evolutions are recorded on video tape for man-machine integration testing. The extraction of data from the video tapes for analysis to determine tasks, time lines of mission events, crew actions, activity records and other crew workload information is a slow process requiring many hours of skilled operator time. Video multiplexing, which allows simultaneous recording from several cameras on the same tape, expands the recording method to multiple crew applications; but it compounds the problem of data reduction. A system is needed which, by employing automation techniques for the extraction of task analysis data from multiplexed video records, will reduce operator skill demands, reduce data turn-around time, and increase the utility of the data for further reduction by computer task analysis techniques.

Phase I requires research of the relevant technologies and specification of the system including hardware, software, and procedures.

Phase II will require production of a fully documented prototype system and demonstration tests at the Naval Air Test Center.

N91-221 TITLE: Incorporation of Artificial Intelligence in Sea Control Helicopters

CATEGORY: Advanced Development

OBJECTIVE: To study the application of artificial intelligence to assist aircrew with automatic detection and classification of air, surface and sub-surface threats. The contractor will apply existing artificial intelligence principles and technologies to integrated ship/air anti-submarine warfare weapon system.

DESCRIPTION: Integrated systems have become increasingly complex. The addition of advanced acoustic, non-acoustic ASW equipment, and target detection and tracking equipment will place an increased workload on air ASW crewmen. The use of artificial intelligence will help to decrease operator workload through automatic monitoring of sensor systems for detection and classification of air, surface and sub-surface targets.

The contractor will research applications of artificial intelligence to the air ASW mission. The deliverable will be a recommended approach to design of an integrated system incorporating AI.

N91-222 TITLE: Integrated Passive Targeting Equipment

CATEGORY: Engineering Development

OBJECTIVE: There is a need for providing the LAMPS MK III aircrew with a passive, integrated targeting system for day/night target classification and weapon targeting. The contractor will survey existing passive targeting systems and technologies available worldwide and will compare alternatives with respect to performance and cost.

DESCRIPTION: The LAMPS MK III will have anti-surface warfare capability with the integration of the Penguin missile. The current targeting method requires the aircrew to radiate the target using the active APS-124 radar system, exposing the aircraft to potential hostile fire. The passive targeting technology should also provide the aircrew with a method for classification of the intended target.

The contractor will provide a detailed comparison of alternatives and a plan to conduct integrated system testing in a Navy LAMPS MK III helicopter.

NAVAL WEAPONS SUPPORT CENTER/CRANE

N91-223 TITLE: Nonlinear Optical Materials

CATEGORY: Exploratory Development

OBJECTIVE: Production of nonlinear optical material(s) having optimum characteristics for use in photonics and opto-electronics applications.

DESCRIPTION: There is a need to produce sensitive (i.e. low excitation energy), high speed optical quality materials for use in photonics and opto-electronics applications. Optimum nonlinear optical materials are required that have been previously available. These applications include, but are not limited to, beam steering and rapid beam deflection/diffraction, optical bistability, optical computing including optical implementation of neural networks (optical neurocomputers), nonlinear optical signal processing, image processing, image understanding, real time (dynamic) holography for reconfigurable interconnects and routing networks, image storage, phase conjugation including phase conjugate interferometry, four-wave mixing, two-wave mixing, beam coupling (i.e. non reciprocal energy transfer), etc. The optical materials for these applications are required to have large optical nonlinearities and reasonably fast response times and may be inorganic, organic, or a combination thereof, such as organometallic compounds. The best material(s) may depend upon a particular application, for example at a particular desired wavelength; however, it is expected that a representative optical material will be demonstrated at the end of the Phase I effort. The Navy has an in-house optical diagnostic facility capable of observing and evaluating important material parameters required for photonics and opto-electronics research, and will assist the contractor in determining relevant parameters for the materials produced during this effort. For

Phase I: Identification of potential candidate material(s) together with preliminary fabrication and demonstration of a candidate material will occur.

Phase II: Refinements to, optimization of, and production of the nonlinear optical material(s) in Phase I for use in photonics and opto-electronics applications will be achieved.

NAVAL OCEAN SYSTEMS CENTER

N91-224 TITLE: Adhesives for Fiber Optic Payout Bobbins

CATEGORY: Engineering Development

OBJECTIVE: To develop an adhesive optimized for high speed fiber optic payout bobbins.

DESCRIPTION: The use of an optical fiber as a high-bandwidth data link between a missile and its controlling platform offers tremendous advantages over microwave and wire technologies. The optical fiber must be precision wound onto a bobbin, placed on the missile, and paid out at high speeds without breaking and with minimum excess optical losses. An adhesive must be developed that can hold the fiber onto the bobbin. The adhesive must exhibit long shelf life, predictable shear strength, minimum degradation at low temperatures, and compatibility with current polymer coatings on fibers. Further, the adhesive must be cost effective and must be wound on payout bobbins. The adhesive must be applied uniformly and without bubbles or any other types of defects, which can prevent precision winding and generate microbending losses. A method of applying the adhesive to the bobbin (or the fiber) must also be developed, tested and demonstrated on wound bobbins. Shear strength measurements will be especially useful in modeling the dynamics of the frictional, aerodynamic, and mechanical forces during a high speed payout.

Phase I: The adhesive formulation shall be developed and laboratory tests conducted on the adhesive to evaluate its performance.

Phase II: 20 payout bobbins will be wound with the new adhesive and subjected to environmental and aging tests. Finally, the bobbins will be tested using laboratory payout machines.

DAVID TAYLOR RESEARCH CENTER

N91-225 TITLE: Development of Shipboard Plastics Waste Processor

CATEGORY: Advanced Development

OBJECTIVE: To develop a shipboard plastics waste processor (PWP) for densifying and sterilizing plastics waste generated aboard ship to comply with existing and anticipated worldwide environmental restrictions on disposal of plastics at sea.

DESCRIPTION: Phase I: Navy ships produce a wide range of waste plastic items and materials, including food contaminated plastics. Identify technology and equipment options for shipboard processing of plastics waste to significantly reduce its volume and render it sanitary and odor-free for extended on-board storage, convenient off-loading, and potential shoreside recycling. Conduct a detailed technical tradeoff study of the identified options, taking into account: waste management requirements; Navy shipboard constraints; safety, health, and habitability issues; and shore handling of processed waste. Select preferred option(s) and identify tentative system configuration and expected performance.

Phase II: Select most promising approach to shipboard processing of plastics waste based upon Phase I results, state of the art developments, and Navy guidance. Design and fabricate a breadboard model PWP and determine concept feasibility. Propose system modifications and evaluation strategy necessary for further development.

N91-226 TITLE: Unmanned Surface Craft Demonstrator

CATEGORY: Advanced Development

OBJECTIVE: To demonstrate an unmanned surface craft concept using HYBRID technology.

DESCRIPTION: A need exists to provide an unmanned surface craft with high speed (40 to 50 knots) in rough water, long range at high speed, high payload capability along with superior motions in waves at a reasonable cost. Technology has progressed to the point where it is particularly feasible for a small craft, such as an unmanned decoy. A HYBRID consists of a marriage of conventional monohull/planing hull, hydrofoil craft, hovercraft, SES, and SWATH as needed. An automatic control system can be used to maintain a stable platform in waves. The expected payoffs for small craft and ships of the HYBRID design are:

a. Large reduction in roll, pitch and heave in rough water.
b. Improved hydrodynamic efficiency at speeds greater than about 20 knots with relatively low speed gradation in waves. Ship does not have to slow down; in fact, it is preferable to maintain high speed.
c. Favorable flow conditions around the HYBRID provide the potential for improved propulsive efficiency compared to conventional craft and ship propeller arrangements.
d. Produces a very small wake, thereby significantly reducing surveillance signature relative.
e. Potential high fuel fraction combined with hydrodynamic and propulsive efficiencies provide greater range and endurance at high speeds.

Phase I: The contractor is to provide a design for a HYBRID craft to demonstrate HYBRID technology. This phase of the proposed effort would consist of design and generation of engineering drawings suitable for fabrication and assembly of a HYBRID.

Phase II: The contractor would fabricate and/or procure the various components required, assemble, perform at-sea trials of a small HYBRID craft, and provide technical data.

N91-227 TITLE: Development of Decentralized Actuators

CATEGORY: Advanced Development

OBJECTIVE: To develop linear and rotary actuators capable of operation independent of a central hydraulic plant.

DESCRIPTION: The Navy is pursuing the concept of decentralizing submarine hydraulic systems. To do this to the fullest extent possible, alternative technology actuators (e.g. electromechanical, electrohydraulic, etc.) are required to operate various pieces of equipment. Linear actuator force/travel requirements range from 500 lb/0.1254 in to 75,000 lb/20 in which actuation times ranging from one to six seconds. Rotary actuator torque/travel requirements range from 260 lb-in/90 deg to 300,000 lb-in/180 deg with actuation times ranging from 1/5 to 8 seconds. Quiet operation and minimal size/weight are important attributes. Phase I: Provide a preliminary design for evaluation.

Phase II: Construct prototype units for testing from those concepts that indicate promise from Phase I.

N91-228 TITLE: Development of Innovative Hydrophobic Membrane for Membrane Distillation Application

CATEGORY: Research

OBJECTIVE: To develop a novel tubular hydrophobic membrane for application in membrane distillation (MD) plants on Navy ships.

DESCRIPTION: The Navy seeks development of a hydrophobic membrane for MD. It shall be in a tubular configuration in the 3 to 4 mm diameter size range with a minimum water flux of 24 gal/sq ft/day when operated on a seawater feed of 212 deg F. The water entry pressure shall be no less than 10 psi when operated at these temperatures.

Phase I: Demonstrate the ability to develop this membrane.

Phase II: Optimize the development of the Phase I membrane and produce the membrane for testing. Long term testing to demonstrate performance capabilities will also be conducted.

N91-229 TITLE: Development of Gas Generators for Submarine Ballast Blowing

CATEGORY: Advanced Development

OBJECTIVE: To develop a gas generator ballast tank blow system that is regenerable at sea.

DESCRIPTION: Confidential level Security Clearances may be required for some GFI during the performance of this topic. The Navy is interested in a compact, fast acting gas generator to produce ballast tank blow gas which is non-toxic, non-corrosive, and non-explosive when mixed in air. It is also desirable that this system be renewable from on board resources.

Phase I: Review and compare all appropriate types of gas generators which could be developed for submarine ballast tank blow. Requirements for design and safe operation of candidate systems will be identified, along with advantages and disadvantages of the concepts.

Phase II: Perform laboratory experiments to develop two chosen concepts and develop prototype designs. Ship impact analyses will be performed using the SSN 688 as the baseline. Scale models will be constructed from one concept for testing in the DTRC ballast blow facility.

N91-230 TITLE: Development of Magnetic Cooling Air Conditioning

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype magnetic cooling AC plant for potential shipboard use.

DESCRIPTION: The Navy seeks development of an air conditioning concept that provides cooling via the magneto-caloric effect.

Phase I: Seeks innovative approaches combined with testing of appropriate portions of the system to prove the concept.

Phase II: Build a prototype of the Phase I system in the 3 to 10 ton capacity range. The target system requires 200 tons of cooling. Size, weight, power consumption, reliability, materials of construction, and safety are critical parameters.

NAVAL RESEARCH LABORATORY

N91-231 TITLE: Milli-meter Wave Chaff

CATEGORY: Advanced Development

OBJECTIVE: Radar reflective material which can be used for airborne self-protection of tactical aircraft in the Milli-meter wave portion of the electro-magnetic spectrum.

DESCRIPTION: Currently the U.S. Navy uses metallized glass chaff for airborne self-protection of tactical aircraft. This effort will investigate innovative approaches to provided that same self-protection into the milli-meter portion of the electro-magnetic spectrum. The material should be capable of being packaged in the standard U.S. Navy expendable cartridge; i.e., 5-13/16" length by 1-5/8" diameter. Access to classified information will be required; therefore, contractor must have personnel and facility clearance at the SECRET level. Specifications may be obtained from the NRL SBIR office.

N91-232 TITLE: Ultra-Wideband Low-Loss Radio Frequency Link

CATEGORY: Research

OBJECTIVE: To extend the radio frequency range of flexible-line links from 18 to 220 GHz

DESCRIPTION: The Navy is interested in new technology and ideas which could provide low loss, lightweight communication links between microwave/millimeter wave airborne electronics systems subassemblies that are remotely located with respect to each other. These links should be flexible and easily stored in confined spaces when not in use. Goubau and Fiber-Optic lines are examples of current technology that tend to meet all requirements except the extension to millimeter waves. The Goubau lines have excessive loss at millimeter waves and fiber-optics transducers are too lossy at millimeter waves. Goubau lines also suffer from RF leakage which limits their application to taut (straight) lines. The fiber-optics type of approach is therefore preferred. However, the Goubau line type of approach should not be excluded from this research.

Phase I: Should be directed towards an assessment of current technological limits (material, physics, fabrication, etc.) as well as possible new promising technologies and materials for broadband links

Phase II: Should be directed towards building a prototype link capable of operating up to 220 GHz (goal which has long life and can survive in an airborne military environment.

N91-233 TITLE: Highly Integrated Multi-Band Receiver

CATEGORY: Research

OBJECTIVE: The radio goal of this topic is to provide the Navy with a small and compact receiver to cover K-band through W-band and above.

DESCRIPTION: The problem is that of intercepting signals over a very broad RF band for the ultimate purpose of detecting and analyzing/identifying them. The primary focus of this topic is the receiver front-end that captures the signals rather than on the signal processing. However, new and innovative approaches may not make signal processing easily separable from the reception process e.g. acousto-optical processing. If a base-band approach is taken, however, no processing beyond formation of the base-band is desired for this topic since analytical processing is already available. Current receiver technology tends to separate microwave and the shorter wavelength millimeter wave technologies resulting in hybrid receiver assemblies larger than desired. New technologies are sought, or at least a top-down design approach is sought, that will integrate the K-band to above W-band (200GHz) receiver functions efficiently for small packaging.

Phase I: Study that examines various receiver front-end approaches and how they would interface with processing form signal analysis. Trade-offs will be made that minimize size and cost and provide an acceptable probability of signal intercept. The deliverable of this phase is a report on the study that shows how the best receiver approach was selected.

Phase II: Provide a breadboard of the receiver front-end including, also, any high-risk features of processing required for signal analysis. A basic performance test will be conducted by the contractor according to the contractor's test plan as approved by the Navy. The breadboard will be delivered to the Navy for further tests.

N91-234 TITLE: Broadband W-Band and Higher RF Medium-Power Amplifier

CATEGORY: Research

OBJECTIVE: The goal of this proposed effort is to develop a medium-power, broadband, W-band and higher RF amplifier that is suitable for airborne applications

DESCRIPTION: The US Navy is interested in new ideas which could overcome the severe constraints of helix RF circuit technology in vacuum devices at millimeter waves. Previous efforts have resulted in very narrowband (radar bandwidth) devices which are very expensive, have short lifetimes and have extremely tight manufacturing tolerances. These devices are not suitable for future naval systems. Specific goals for the subject device are 9) instantaneous bandwidth covering W-band and to as high as 220 GHz, 2) power output of 200W CW, 3) gain of 50 dB, 4) overall efficiency of 30 percent, 5) device-operating-voltage less than 15KV with periodic permanent magnet focusing, 6) potentially integrable with devices that result in continuous coverage down to 18 GHz and, if possible, 7) total coverage form J-band to 220 GHz in a single device/envelope.

Phase I efforts should be directed towards a theoretical analysis of the most promising RF structure and device concept. The analysis should include all the engineering trade-offs with the advantages and the disadvantages carefully documented.

Phase II efforts should be directed towards the fabrication and cold test of the RF structure and electron beam transmission. A complete brassboard prototype of the cold test device should be delivered to the US Navy for laboratory testing.

NAVAL TRAINING SYSTEMS CENTER

N91-235 TITLE: High Definition TV Projection Via Single Crystal CRT Faceplate Technology

CATEGORY: Advanced Development

OBJECTIVE: To perform research for the design and construction of high performance full color video projection system using single crystal phosphor faceplate technology.

DESCRIPTION: Single crystal phosphor faceplates have been the object of research directed toward producing high resolution, high brightness video projection CRTs. Improved video projection systems are needed for use in applications ranging from flight simulation displays to command and control displays. Current research of Ce:YAG single crystal phosphors has promise of producing a 3 inch diameter CRT faceplate capable of outputting 2000 lumens of light across a wavelength range of 470-670 nanometers (peak output @ 530 nm) and displaying up to 4000 scan lines per frame. Further research is required for

improvement in the light output efficiency and schemes for color delivery in order to design and construct a full color high performance video projection system. Successful completion of this effort should result in a color video projection system with increased brightness and resolution from a smaller physical footprint and at a lower cost than current high performance video projectors.

Phase I: Consists of a study on the methods of further increasing the light output and provision of a full color display system. An area of specific interest is methods for growing larger single crystal boules, on the order of 4 to 5 inch diameters, to be used in making substrates for the epitaxial growth of single crystal phosphor faceplates. Larger faceplates lead to increased net light output and/or reduction in electron beam current required. Also, study and evaluation of projector electronic/optical/mechanical design for using single crystal CRTs to their best advantage in a full color video projection system is required.

Phase II: Use Phase I results in the construction of a deliverable full color single crystal CRT projector to the government for testing in a visual simulator application.

N91-236 TITLE: Low Cost Head/Helmet Mounted Display for Simulation

CATEGORY: Advanced Development

OBJECTIVE: To design and develop low-cost visual display system that is either head or helmet worn. The final system will be binocular, full color, 1000 line minimum resolution, 60 by 90 degree minimum instantaneous field of view, and light weight.

DESCRIPTION: Head/helmet mounted display systems, when coupled with a head attitude sensor, have many applications in simulation and training. Past wide field of view display systems have been both costly and heavy. Technology has progressed enough to offer a lightweight, low-cost version. The final system should be easy to use and be aesthetically pleasing. The display would have applications in deployable training systems, low-cost flight simulators, and table top training systems. The display would afford the user some of the benefits of a larger dome display when space or other factors did not allow for its installation.

Phase I: The offeror will perform a preliminary concept design with conformance to the specifications stated above. The offeror will also show ability to construct a prototype of said device.

Phase II: The offeror will finalize display design and construct a prototype.

N91-237 TITLE: Low Cost System for Verification of the Cuing Fidelity (Motion/Visual/Instrumentation) of a Total Simulator

CATEGORY: Advanced Development

OBJECTIVE: To satisfy the requirement for a low cost system that will verify that a simulator has met "end-to-end" cue fidelity requirements in it's visual, motion, and instrumentation subsystems.

DESCRIPTION: There is currently no unified system or procedure that verifies that a simulator has met design requirements for cuing fidelity in its visual, motion, and instrumentation subsystems. Generally, pilot feedback and selected testing of some hardware is the only quantitative measure of the total dynamic behavior of the simulator.

Phase I: Design a compact test and evaluation system made up of off-the-shelf hardware and easily deployable to any site. The design shall emphasize simplicity of operation and not require intensive training. The end product for Phase I will be a detailed report with all specifications for the integration of a prototype test and evaluation package.

Phase II: Will be directed towards the integration of prototype hardware, and the demonstration and evaluation of the system's performance. The end product would be portable off-the-shelf test hardware that could be used anywhere in the fleet to assure that trainers are not accepted until cue fidelity has been verified.

N91-238 TITLE: Subject Matter and Pedagogical Experts for Training Device Curriculum Development and Control

CATEGORY: Advanced Development

OBJECTIVE: To embody general teaching principles in a teacher expert system that will query subject matter experts for principles, examples, performance indicators and qualification thresholds, then to conduct and refine the course of study. This expert system teacher would be re-used to develop curriculum for various new training devices or for modifications to existing devices.

DESCRIPTION: The teacher of a class of students often is restricted in the amount of individual attention given to each student's needs, and therefore attempts to optimize for the class. A teacher with a single student selects a teaching strategy based upon an inference of the student's learning stage from an evaluation of the student's performance. Teaching is carried out by generation of examples and explanations, and verified by generation of questions and problems. Speed and accuracy are often used to measure progress. The teacher must also create the syllabus. Student weaknesses are diagnosed by inference from the errors students make, then exercises are selected to remediate the weakness. Finally, the teacher must allow the student some degree of control, as well, by allowing the student to ask questions. Training device technology will benefit from expert systems which can gather required subject matter from the domain expert, tailor a course of instruction to individual students, and refine the course materials over time. Gathering the domain includes rules for common error and misunderstandings of students, facts and their relationships, procedures of the domain, examples, theory, and practice. If the domain contains abstractions, then sufficient basis concepts or common sense examples are needed to draw analogies. A hierarchy of concepts is needed so that the teacher can choose top-down vs bottom-up, and breath vs depth teaching strategies.

Phase I will identify pedagogical features, identify requirements for gathering of domain information and select an expert system shell.

Phase II should assemble the expert system then demonstrate curriculum development and control for an aviation command and control task.

N91-239 TITLE: Low Cost Automatic Scenario Generator (ASG)

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to determine the system characteristics and demonstrate the feasibility of a low cost automatic scenario generator (ASG) for aircrew training systems such as CV-WST, F-14D, A-12.

DESCRIPTION: The ASG would replace the current non-automated scenario generation process, significantly reducing the time and effort to create scenarios, and therefore increasing the overall productivity of training systems. In selected cases, an ASG could lead to self-paced student shipboard training.

Phase I: Provide a report to describe and assess the current scenario generation process. The study will evaluate, quantify, and describe the latest hardware/software technology (e.g., expert systems, Ada, microprocessors) to automate the scenario generation process and yield a product called an automatic scenario generator (ASG) for aircrew training systems.

Phase II: Consists of three products -- a detailed task analysis of the scenario creation process, a detailed system/hardware/software requirements report, and a feasibility demonstration of an automatic scenario generator to be delivered to the government for testing.

NAVAL WEAPONS CENTER

N91-240 TITLE: Monopulse Radome Error Compensation in the Presence of Aperture Blockage

CATEGORY: Exploratory Development

OBJECTIVE: To determine the technical merit and feasibility of a fixed but robust, or adaptable compensation technique for the radome error compensation of a monopulse antenna in the presence of a large aperture blockage.

DESCRIPTION: Radomes which have large aperture blockages exhibit large target spatial errors to the radar tracking system. These errors, if not compensated by subsequent signal processing, have a detrimental effect on tracking performance. The intercept homing performance of the carrying platform is subsequently affected.

Current techniques have focused on platform specific solutions. These solutions have not identified critical problem parameters, signal processing, evolving technology, or algorithmic designs, which, if not impeded by platform constraints, would successfully correct the radome aberrations caused by the blockage.

Phase I: Conceptual studies will be presented for evaluation.

Phase II: Evaluation to prove feasibility, and determine the best approach(es). Then development and testing of the algorithm(s) determined from the best approach(es).

N91-241 TITLE: Digital Computer Modeling of Directed Energy Weapons (DEWS)

CATEGORY: Engineering Development

OBJECTIVE: To develop a digital computer model of tactical directed energy weapons (DEWs) and integrate the model into existing one-on-one and many-on-many simulations and models used to assess aircraft and weapons survivability.

DESCRIPTION: The threat to aircraft and weapons systems now includes DEWs such as laser range finders and laser target designators. This threat is not being considered in most on-going survivability analysis for three reasons:

1) Although the potential for directed energy threats is well established both in terms of effectiveness and feasibility, few tactical weapons have been fielded. The practical nature of the threat is unknown.

2) The damage mechanisms of DEWs are difficult to quantify because they are a function of parameters such as: exposure duration, directed energy transmission frequency, atmospheric conditions, and target field of view, as well as target shape and material characteristics.

3) Key vulnerable components of many aircraft and weapon systems are the eyes of the personnel involved in operating the system. It is difficult to quantify the effect of directed energy attacks on vision and the impact of a wide spectrum of vision degradation. Regardless of whether a tactical weapon is fielded and despite the difficulty in determining the effectiveness, Pk, of such weapons against a wide range of targets; the presence of thousands of pseudo-weapons on the modern battlefield requires that aircraft survivability be addressed in the context of directed energy threats.

Phase I: Models addressing the physics of the propagation of directed energy are available. It remains to combine such models with models that address the characteristics of a DEW system and the interaction of directed energy on a specific set of targets. Research should focus on the characterization of a weapon system to the extent that the practical utility of DEWS is addressed. The research should also provide survivability analysts with a model that accurately determines the energy reaching various target components. It would then be up to the analysts to devise a test to determine the effect the specified energy would have on the target.

N91-242 TITLE: 6-Inch Integrated Aero/Thrust Vector Control (TVC)

CATEGORY: Engineering Development

OBJECTIVE: Design and build an innovative, high performance, and light weight integrated (common actuators for Aero and thrust vector control (TVC) Aero/TVC)) packaging scheme for a 6-inch tail-control missile. The main product from this feasibility study would be the linkage design that connects the control actuation system with TVC and control fins. The blast tube and nozzle designs are not required for this development.

DESCRIPTION: Currently, small diameter Air-to-Air missiles (5 to 6 inches) with Thrust Vector Control do not exist in the U.S. inventory. The agility of a missile of this size would be greatly enhanced with Aero and Thrust Vector Control. In order for a integrated Aero/TVC to improve the performance of a small diameter missile the system must be fast, stiff, accurate, light-weight, and fit into a small envelope. This system should have a minimum bandwidth of 35 Hz because of the airframe response of a small missile. The control linkage has to be stiff and allow minimum dead time or backlash. This would prevent possible problems with flutter. The system should have repeatable accuracy of 5% of the commanded position. This system must be designed with high priority given to the weight. This system has to fit in an envelope that is constrained by a 6-inch outside diameter missile, a 3-inch outside diameter blast tube, and nozzle assembly that has an outside slope of 15 degrees and an outside exit diameter of 5.25 inches. Also, this system must be any type of TVC that can provide a minimum of ±7.5 degrees of thrust vector angle with less than 5% thrust loss. A movable nozzle system would be acceptable. The integrated control actuation system should be common to both the Aero and TVC system. The system that controls the missile fins should provide ± 5 degrees, have a minimum slew rate of 600 degrees/sec at 1/2 maximum operating torque, and provide a maximum operating torque of 1200 in-lbs. This system must include the control actuation power supply. The maximum length of the blast tube is 8 inches.

Phase I: Phase I should consist of a feasibility study that identifies and analyzes a prototype design.

Phase II: A bench model will be developed and built during Phase II. Also, during Phase II the model will be evaluated for performance.

N91-243 TITLE: Electro-Rheological Fluid Damper

CATEGORY: Exploratory Development

OBJECTIVE: Develop an active damper for missile control fin actuation systems using electro-rheological fluid.

DESCRIPTION: Electro-rheological fluids are fluids which exhibit a change in viscosity when exposed to an electrical field. The purpose of this project is to demonstrate that this technology can be used to provide active damping for a missile flight control actuator. The project should include detailed design, fabrication of a demonstrator unit, and extensive performance testing.

N91-244 TITLE: Biometal Actuation

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the feasibility of using biometal in various deformable skin actuation schemes.

DESCRIPTION: Biometal is a Nickel/Titanium alloy which changes shape when heated and has excellent shape memory properties. Missile designers have proposed flight control actuation schemes in which the skin or either a control fin of the missile body itself would be deformed to produce the desired aerodynamic forces. Potential advantages of deformable skin systems include reduced radar cross section, and reduced cost and increased reliability since there would be fewer moving parts.

N91-245 TITLE: Spherical Boron Slurry Particles

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate a process for producing low cost ($5.00 to $10.00 per pound) spherical boron particles 2 to 5 microns in diameter using B203 as a raw material.

DESCRIPTION: Boron slurry fuels have the highest energy density product of any known fuel, however, the present price of amorphous boron is unacceptable and the fuels made from it have unacceptably high viscosity.

Phase I: Should be directed towards the development of a method to process spherical boron particles 2 to 5 microns in diameter using B203 as a raw material. The result of Phase I will be a production of laboratory scale quantities of the material and a report outlining the approach that will be undertaken in Phase II with sufficient data to demonstrate the feasibility of producing the particles at a low cost.

Phase II: Shall address the large scale preparation of the spherical boron particles prepared in Phase I. 200 pounds of the material should be synthesized and forwarded to the government for testing.

N91-246 TITLE: High-Energy Fuel Gel Scale-up and Production

CATEGORY: Exploratory Development

OBJECTIVE: To define and document procedures or processes for preparing one to five hundred gallon batches of high-energy gelled ramjet fuels.

DESCRIPTION: High-energy fuel gels are currently being evaluated by the Navy for advanced long-range air breathing missiles. This includes the preparation in the laboratory of liter size batches of the gels for chemical and physical properties related tests. However, for fuel control and combustion tests, multi-gallon size batches are needed.

Phase I: A report outlining procedures and/or processes for preparing gel formulations identified by the Navy.

Phase II: Delivery of one to five hundred gallon batches of gelled fuel manufactured in accordance with procedures and/or processes developed under Phase I.

Specifications will be provided by the Naval Weapons Center SBIR office.

N91-247 TITLE: High Voltage Switch For Slapper Detonators.

CATEGORY: Advanced Development

OBJECTIVE: The objective of this work is to design, fabricate and conduct qualification tests of a high voltage switch to be used in safety-arming devices.

DESCRIPTION: High voltage switches that are currently available for use with slapper detonators are either very expensive, have a limited lifetime, or have a very low breakdown voltage. It is desired to find a switch that is repeatable for at least 100 full current discharges into a 5 milliohm load with no evidence of "stalling". "Stalling" is defined as a condition whereby the discharge waveform "stalls", i.e., stops rising for a short time before continuing to the peak discharge current. Stalling can result in failure to fire the slapper detonator.

It is desired to receive proposals for both vacuum and gas-filled switch concepts. Specific requirements for the switch are:

Electrical:
1. Static Breakdown Voltage: 5 kVdc
2. Peak Current: 6.0 kA (pulse)

Size:
1. Volume: 0.2 cubic inch

Cost:
1. $30 (100 each)
2. $24 (1,000 each)
3. $18 (10,000 each)

N91-248 TITLE: Adaptive Contact Sensor

CATEGORY: Advanced Development

OBJECTIVE: The objective of this work is to design, fabricate and conduct qualification tests of an adaptive contact sensor to be used in guided missiles.

DESCRIPTION: Current contact fuzes used in Navy guided missiles have a fixed firing threshold. The fixed firing threshold is intentionally fixed at a level that is certain to never fire before reaching the intended target, but will provide reasonable assurance that the contact sensor will provide a firing signal when the missile hits its target.

Safety is not an issue as the warhead safety-arming device ensures that the missile reaches a safe distance from the launcher before the warhead can be fired. The challenge here is to formulate a firing system that will measure the flight background environment during flight and adjust the firing threshold to obtain the maximum sensitivity to target impacts. Basic requirements for the device are as follows:

Shock:
1. The sensor shall contain a transducer that will sense when the missile contacts the target.
2. The sensor shall be capable of operating during and after a shock of 20,000 gravity units with a pulse duration of 0.5 milliseconds.

Size:
1. Volume = 0.6 - 0.8 cubic inches

Cost:
1. $435 (100 each)
2. $320 (1000 each)

N91-249 TITLE: Optical Fiber Guidance Payout Tension and Torque Measurement System

CATEGORY: Engineering Development

OBJECTIVE: To design and fabricate a magnetic levitation system to measure the real time tension and torques generated by an optical fiber. When complete, the measurement system will provide a test bed for measuring, identifying and characterizing minute fiber adhesive forces; fiber guidance payout forces and validating coefficients for analytical models from a static or rotating payout system.

DESCRIPTION: The test bed will consist of: magnetic bearings, mechanical design data acquisition and data reduction systems. These subsystems will be integrated into a highly accurate fiber payout tension and torque measurement system (TTMS). The tension and torque measurement system requires the following: (1) Relative collection of tension and torque data, (2) Vibration rejection to ensure true force and torque data, (3) Sampling rates sufficient to detect nonlinear dynamic loads, (4) Precise calibration procedures and hardware, (5) Axial tension fidelity from 0 to 2500 gm, (6) Centerline torque fidelity from 0 to 2500 gm-cm, (7) 0-2% resolution at 500 Hz, 2500 gm, and (8) Compensation for off-axis payout angles and rates.

The system must be capable of operating in static, free, and open and closed loop controlled- spinning bobbin mode. Both a high speed digital servo controller and a high speed, high-resolution data acquisition system are required for force control and data measurements. The data acquisition system must be able to quickly and efficiently acquire and analyze data.

The magnetic measurement suspension system is an ideal concept for the measurement of the bobbin multidimensional forces when decoupled from the measurement axis. The complete system will provide six degree-of-freedom (6-DOF) measurements of bobbin forces and torques up to the frequency of the measurement sensors.

Phase I: Design and development effort to demonstrate the approach.

Phase II: Development of a government data package, and the fabrication of a measurement system for delivery to the government for testing per the approach outlined in Phase I and a standard government bobbin configuration.

N91-250 TITLE: Development of Prototype Multiple Aircraft Range Display System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a prototype state-of-the-art graphics display system for real-time display of data from a flight test. This task will include development of software for use on existing available hardware. This data will include positions of multiple aircraft. Location of multiple threat weapon system configurations and other test resources, multiple weapon flyouts. aspect angles, and threat weapons effectiveness. The prototype user will have the capability of selecting different display screens and editing displayed information.

DESCRIPTION: Development Phase I: (1) establish detailed requirements for the Prototype Multiple Aircraft Range Display System; and (2) research hardware and software already available which could be modified to perform this task or could be used to partially satisfy the requirements for the task. Different displays may be required for test managers, test conductors, and military observers. Human engineering factors are an important facet of this development.

Phase II: Develop a prototype system based on the requirements defined in Phase I and user feedback. Impact: Results of development of this prototype will be used to define the requirements for the new Code 644 range display system.

N91-251 TITLE: Coupling of Optical Fibers to Detectors in Evacuated Dewars

CATEGORY: Exploratory Development

OBJECTIVE: To determine the feasibility of using optical fibers to simplify optical designs in multi-detector sensor systems. If this research is successful it would significantly reduce the cost of cooled sensor systems and would be procured and installed in anti-air missile systems.

DESCRIPTION: Some sensor systems require mounting the detectors in evacuated dewars. In order to provide full azimuthal coverage, this currently requires several detectors mounted in multiple dewars. Generating the desired field of view also requires having detector element shapes which are difficult and expensive to produce and whose effectiveness is reduced by the detector shape. By accepting the incoming energy into appropriately shaped fiber bundles, which are then coupled to a single array of more efficiently shaped detectors in a single dewar, the optical complexity and expense of these systems can be greatly reduced.

Phase I: Would be a study examining the approach which will be used to meet the requirements addressed above with sufficient data to demonstrate feasibility and make a well grounded selection of technology to be used.

Phase II: Should use the approach outlined in Phase I to produce one detector system and deliver it to the government for testing.

N91-252 TITLE: Neural Network Controlled Automatic Gain Control for Low Cost IR Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To produce a low cost hybrid infrared/neural network sensor with on-chip automatic gain control. If successful, the developed technology demonstrates the feasibility of combining low cost IR sensors with neural network processors to produce low cost smart sensors.

DESCRIPTION: The most overwhelming factor limiting the widespread use of imaging IR sensors in various applications is the inability to deal with the volume of information produced by these sensors. Neural networks, because of their parallel nature, have the ability to deal with the large volume of information produced by these sensors. The bottle neck in today's technology is the interface between the IR imaging sensors and the neural network processors. The purpose of this project is to remove the integration bottle neck and demonstrate feasibility using an automatic gain control (AGC) problem.

Phase I: Should integrate an existing IR focal plane array sensor with neural network hardware to solve the AGC problem.

Phase II: Should expand the complexity of the problem focusing on resolution, connectivity, and related issues to produce a more generic sensor package.

N91-253 TITLE: Magnetically Supported Ultraprecision Bearing Development

CATEGORY: Advanced Development

OBJECTIVE: To develop and demonstrate the capability to produce a magnetically supported bearing for ultraprecision rotary motion usable in a variety of seeker, scanner, or other optical/mechanical applications where a precise, small, low noise, low friction, low consumable, and very stiff bearing is required.

DESCRIPTION: As higher speeds and more precise motions are employed, the dynamic limitations of ultraprecision ball or roller bearings become apparent. Stiff bearings and structures can be achieved with gas static bearings but with the penalty of gas consumption, which will limit run times in remote applications. A magnetically supported rotary bearing could in principle be designed to fill this need with the low power electricity supplied from existing system sources. As a demonstration, the following bearing shall be designed and demonstrated:

Specifications for demonstration of representative technology:
Overall diameter less than 8"
Clear aperture 6"
Thickness less than 2"
Dynamic performance up to rotation rates of 100 Hz:
Stiffness to axial or radial deflection greater than 5 x 105 lbs/in
Radial and axial run out less than 3 x 10-6 in
Electrical power consumption shall be less than 10 W

Specific provision for integral torque motor drive and high resolution encoder shall be made for test purposes. Special attention should be made to be able to scale the design, both larger and smaller than the nominal design, especially to miniaturization without sacrifice of stiffness or accuracy.

N91-254 TITLE: Active Matrix IR Scene Generation via Polysilicon Integrated Circuit Sources

CATEGORY: Advanced Development

OBJECTIVE: To develop and demonstrate dynamic IR scene generation hardware capable of rapid update times and near/mid/far IR operation utilizing polysilicon integrated circuit infrared sources in an active matrix array geometry.

DESCRIPTION: Broadband infrared sources utilizing integrated circuit (IC) technology have been demonstrated. Such devices make use of common semiconductor photomask/etching methodologies to yield an extremely simple and compact, glowbar-type resistive silicon strip. These integrated circuit infrared (ICIR) sources may be fabricated in the form of large matrices of single source elements. Each of the single element sources may be driven by on-pixel electronics as in a focalplane array (FPA) or may be energized by an active matrix addressing scheme (active matrix addressing shall be used in this introductory device). The use of polysilicon bridge material opposed to thin metal films affords higher operating temperatures (1000°K) and thus better spectral dynamic range in the short to mid-infrared. The similarities between ICIR and focal plane array construction permits ready transfer of manufacture technology and use of existing microelectronics industry equipment and infrastructure. An ICIR's inherently small size, weight, cost, and power requirements make it ideally suited to both laboratory and field ruggedized test sets.

Specifications for demonstration device include:
- linear array of at least 8 pixels
- 1000 Kelvins or greater operating temperature
- 1/10 watt or less total dissipation power
- 20 x 20 x 0.8 micron minimum bridge dimensions

N91-255 TITLE: IR Conical Scan Tracker In The Loop

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of RF seekers with aperture blockage

DESCRIPTION: Many of the IR seeker designs for multispectrum guidance use a free gyro seeker with conically scanned arrays of detectors. The performance of these seekers needs to be tested in a cost effective manner in the laboratory. A simulation system capable of injecting signals into the signal processor which simulates the outputs from the conically scanned arrays is needed. The simulator must provide real time, time domain input signals which represent the target and a variety of background,

countermeasures, and noise in the conically scanned coordinates. The objective of this initiative is the definition, design, and demonstration of a tracker in the loop capable of testing conical scanned seekers. The inputs must represent images in any of the IR spectrums from 1 to 12 microns. The ability to dynamically control the inputs in real time based on a missile simulation of the geometry is required. The system will be integrated with existing missile simulation computers to provide a test facility for conically scanned IR seekers for multispectrum guidance.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to design and develop a simulation system capable of injecting signals into the signal processor which simulates the outputs from the conically scanned arrays.

N91-256 TITLE: Efficient Optical Surface Finishing of Ultrahard Dome Materials

CATEGORY: Exploratory Development

OBJECTIVE: To significantly reduce the cost and improve the producibility and surface quality of ultrahard dome materials such as sapphire and spinel.

DESCRIPTION: High performance missile domes will require ultrahard materials such as sapphire, spinel, or diamond. Such materials are presently fabricated using diamond abrasive grinding and polishing. This process is slow and very expensive and results in substrate subsurface damage, which directly limits optical and rain erosion performance. It may be possible to employ chemical/mechanical or ion beam techniques to this finishing process. High material removal rates and excellent finishes have been reported on sapphire on small, flat surfaces. If this or similar processes can be scaled and applied to steeply curved surfaces, it is likely that the objectives of this effort can be realized. To demonstrate progress a dome shall be fabricated of sapphire or spinel starting from a near net shape blank in less than 40 hours of fabrication time. Assuming that the ongoing SBIR effort in dome blank fabrication is successful the combined effort could result in very real and significant reduction in dome cost.

Suggested demonstration dome dimensions and specifications are as follows:

Figure irregularity shall be 2 fringes maximum at 6328 A over any 2" aperture on each surface. Rms roughness measured using a WYKO profilometer or similar instrument <15 Å rms, over a scan length of 0.25 mm. Typical IR dome dimensional tolerances apply to wedge, centration of surfaces and radii match.

N91-257 TITLE: Polishing of Poly-crystalline Diamond Films

CATEGORY: Exploratory Development

OBJECTIVE: Develop polishing techniques to provide optical quality finishes for poly-crystalline diamond films on flat and curved surfaces.

DESCRIPTION: Poly-crystalline diamond films grown by plasma enhanced chemical vapor deposition offer a means to protect infra-red window and dome materials in severe environments. Diamond deposited in this manner tends to have large grain size and random crystal orientation which contributes to reduced optical performance because of scatter. Polishing of the growth surfaces will be necessary to reduce the scatter effect. Optical quality finishes of about 25 Å RMS roughness or better will be needed. This types of surface finish is necessary for poly-crystalline diamond-coated flat and curved surfaces up to two inches in diameter.

N91-258 TITLE: Anti-Reflection Coatings for Use on Diamond Films

CATEGORY: Exploratory Development

OBJECTIVE: The aim of this program is to develop materials and deposition processes to fabricate optical thin films to provide anti-reflection (AR) coatings for poly-crystalline diamond films in high temperature, oxygen-containing environments.

DESCRIPTION: The durability and extremely high thermal shock resistance of poly-crystalline diamond offer a means to protect IR window and dome materials from erosion and environmental attack while improving optical performance, thermal shock resistance and lifetime. Optical quality coatings that can be deposited and adhere to diamond must be developed to provide useful AR coatings that can survive extreme environments. The AR coating should be optimized for transmission in the 8-12 μm region. Ideally, it should retain good transmission from the ultraviolet to millimeter wavelengths. A secondary function of the AR coating is to protect the diamond from oxidation by the atmosphere at temperatures up to 1000°C. Deposition techniques

supplying dense, uniform films will be needed. An emphasis will be placed on the ability to scale the processes. Reflectance and transmittance will be used for optical property measurement. Mechanical properties such as stress, adhesion, and thickness uniformity using optical microscopy and scattered light analysis of the films will be determined.

N91-259 TITLE: Switchable Electrically Conductive Polymers

CATEGORY: Exploratory Development

OBJECTIVE: Develop air-stable polymer films that can be electrically switched between electrically conductive and non-conductive states.

DESCRIPTION: Free-standing electrically conductive films are required for microwave shielding. The ideal film can be switched rapidly between conductive and non-conductive states by an electric current. It will be air-stable in both states, or may have a non-conductive coating that protects it from air. It should be switchable 10^5 times with little degradation of its properties in either state.

Phase I: Demonstrate air-stable switchable structures and measure microwave absorption at X-band in the conductive and non-conductive states.

Phase II: Optimize absorption and transmission characteristics, switching speed, air stability and reversibility.

N91-260 TITLE: Video Geometric Processor

CATEGORY: Engineering Development

OBJECTIVE: To develop a video processor which can take video scenes generated by a fast graphics computer and do real time rotation, translation, and zooming for input to the tracker hardware of an imaging missile system. This must be done at sufficient speed to support closed-loop tracker Hardware-in-the-Loop (HWIL) simulation.

DESCRIPTION: Testing of imaging missile system trackers in closed-loop HWIL simulations require the use of computer-generated imagery so that, for each video frame, the view of the target as seen by the seeker can be generated by the graphics computer in a position which accurately reflects the change in the missile's perspective due to guidance commands given during the previous frame. Since the simulation computer requires most of that frame time to compute the new missile position there is precious little time for the graphics computer to generate a new scene. However since only some elements, such as the rotation, translation, and zoom factor of the target as seen by the missile, are extremely time critical, it is possible to split up the operations. The graphics computer can take the time it needs to generate a view of the target scene from the proper perspective and then send that video image to a special geometric processor which can do the required time critical operations in a time period much less than the frame time. This is the approach taken now in the Imaging Systems Lab of the Simulation Laboratory using an in-house built Zoom Processor. However, this Zoom Processor does have some operational problems, was very expensive to build and is one-of-a-kind. This development effort would replace this Zoom Processor and give the same capability for other tracker HWIL simulation workstations, which will be critically needed for present and future imaging missile system programs.

Phase I: Should consist of a study to identify all time critical operations, develop the analytical and architectural approach and complete design specifications, and identification of potential problems which might introduce unacceptable video artifacts.

Phase II: Should use the approach outlined in Phase I to develop a working Geometric Processor and deliver it to the government.

N91-261 TITLE: Multivariable Autopilot Design Using H-infinity and Mu Synthesis

CATEGORY: Exploratory Development

OBJECTIVE: To investigate the feasibility of using recent control design techniques to design either missile autopilot that is operational over the entire flight regime, or an adaptive-type autopilot that varies as the flight environment changes.

DESCRIPTION: Tactical missiles today typically employ an autopilot that is designed at different points in the flight regime. The autopilot parameters are then switched as some measured or estimated variable(s) change during flight. With the advent of increased computational power, and new multivariable control design techniques, the possibility exists for a more advanced multivariable autopilot design. The study should focus on how the design techniques would handle the changing flight environment, and how they would handle the stability and performance-related design specifications.

N91-262 TITLE: Generic Guidance Integrated Fuzing Air-to-Air Missile Simulation

CATEGORY: Advanced Development

OBJECTIVE: To develop a generic 6 degree of freedom Guidance Integrated Fuzing air-to-air missile simulation. The simulation will give the Navy the capability to perform analysis in the area of Guidance Integrated Fuzing for air-to-air missile development.

DESCRIPTION: Modern Navy missile development is progressing toward an integrated guidance and fuzing system. The purpose of this project is to provide the Navy with the simulation capability to further the investigation of the benefits of Guidance Integrated Fuzing and promote advanced development into upgraded weapons systems.

Phase I: Modify an existing 6 degree-of-freedom generic air-to-air missile simulation to incorporate terminal fuzing features. Capabilities should include simplified changes for fuze waveforms and N-point aspect dependent target models.

Phase II: Expand on the developments of Phase I to increase the simulation capabilities with transition modes for long range guidance, fuze mode closing guidance, terminal fuzing, and detailed N-point aspect dependent fuzing target models. The final development will be delivered to the Navy as a fully capable simulation for future missile development utilizing Guidance Integrated Fuzing.

N91-263 TITLE: IR Physical Model Generation

CATEGORY: Exploratory Development

OBJECTIVE: To provide realistic physical models to be used in testing of infrared proximity fuzes.

DESCRIPTION: Naval Weapons Center (NWC) is developing a capability for the use of physical models in the testing of long-wave infrared proximity fuze hardware (target-detecting devices). The hardware under test will include developmental optical systems, signal-processing software, and complete assemblies. The models will be typically 1/10 to 1/4 scale simulations of targets of interest, including aircraft and anti-ship missiles. Testing will be carried out at scaled distances of less than 100 feet, and target detail is important. Models should be capable of showing aerodynamic heating and internal heat sources, and background reflections. NWC invites proposals to implement this physical modeling approach, either with an independent approach to scene generation or as further development of the scale models now being used at NWC.

Candidate approaches must have minimal flicker or graininess and be capable of arbitrary target aspect. The background will be generated independently and is the subject of a companion SBIR topic description.

Phase I: Should establish a workable scene generation technique and provide a simple proof-of-concept hardware demonstration.

Phase II: Will use the concept of Phase I and provide a single working scene generator suitable for use with NWC's models.

N91-264 TITLE: IR Background Scene Generation

CATEGORY: Exploratory Development

OBJECTIVE: Provide realistic background for physical models used in testing of infrared proximity fuzes

DESCRIPTION: Naval Weapons Center (NWC) is developing a capability for the use of scale models in the testing of long-wave infrared (LWIR) proximity fuzes. The fuzes (target detecting devices) are passive IR devices operating in the 8- to 12- micron infrared band. The device under test might include developmental optical systems, signal-processing software or hardware, and complete assemblies. The models will be typically 1/10 to 1/4 scale models of targets of interest, including aircraft and anti-ship missiles. A perceived need is for an infrared background generator which can produce realistic infrared background, especially of sea-surface reflections. The background generator will produce time-varying background scenes derived from LWIR video imagery provided by NWC. These scenes will be used as background during model encounters at scaled fuzing ranges.

Phase I: Should establish a workable scene generation technique and provide a simple proof-of-concept hardware demonstration.

Phase II: Will use the concept of Phase I and provide a single working scene generator suitable for use with NWC's models.

N91-265 TITLE: Radar System Upgrade

CATEGORY: Engineering Development

OBJECTIVE: To modularize an existing X-band Inverse Synthetic Aperture Radar (ISAR) system to allow emulation of a wide variety of radar guidance systems.

DESCRIPTION: Missile guidance systems being proposed and systems presently under development have a wide array of operating parameters. These parameters include differing operational frequency bands, pulse characterizations, PRFs, and power output. Currently, to emulate the different guidance radars and their modes of operation requires different, unique, emulation system for each. NWC currently has an X-band ISAR under development. To allow the ISAR to keep current with future state-of-the-art advances, it is proposed to modularize the ISAR system to the extent necessary to allow emulation of the different guidance parameters as required. The conversion from one set of parameters to the other should be accomplished with minimal impact on the current system.

Phase I: A conceptual study will be made to ascertain the necessary modifications to the ISAR hardware and software to accomplish the conversion.

Phase II: Will consist of the design, development, and delivery of the modified ISAR.

N91-266 TITLE: Image Processing of Radar Data

CATEGORY: Engineering Development

OBJECTIVE: To convert in near real time, wideband coherent data collected from an Inverse Synthetic Aperture Radar (ISAR) system into range profiles and two dimensional cross-range images.

DESCRIPTION: Radar glint and scintillation returns from a target have an impact on missile guidance, causing increased miss distances to occur. The sources of glint and scintillation appear to be random in nature and are not fully understood. By mapping radar glint and scintillation return sources from various targets, a better understanding of the phenomena can be developed, which would aid in the elimination of these affects on missile guidance systems. Radar imaging would also aid in the development of a method to differentiate between friendly and enemy aircraft. The Navy is presently under contract for the development of an instrumentation radar which will generate the raw radar data for the imaging task. However, the software necessary to convert the raw radar data into images on a near real time basis does not exist. Although software algorithms are presently available for converting radar data into images, they are not able to take advantage of the full capabilities of our state-of-the-art ISAR.

Phase I: Conceptual design of the necessary algorithm will be developed to prove feasibility.

Phase II: Development and testing of the software necessary to implement the algorithm developed in Phase I and delivery of the final product.

N91-267 TITLE: Free Gyro Angle, Rate, and Phase Measurement

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of IR seekers

DESCRIPTION: Very small free gyro seekers are being designed for application to multispectrum guidance systems. These seekers need to obtain very precise measurements of the gyro gimbal angle and the rate and phase of the gyro motion. Existing systems are limited in the accuracy and linearity of these measurements. Angle measurements accuracies of 0.1 degrees with rate accuracies of 0.1 degrees/second and phase measurements to 0.1 degrees are desired. These accuracies should be maintained over a temperature of 40 to 70 degrees centigrade. They should remain constant over the life of the gyro and in various conditions of motor drive. The objective of this initiative is the design and demonstration of a method of measurement in the small gimbals of a free gyro. The gyro hardware of the Multispectrum Guidance program can be used to demonstrate this capability. The space available for this measurement is extremely small. The total seeker diameter is about two inches.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to design, develop and demonstrate a method of measurement in the small gimbals of a free gyro.

N91-268 TITLE: Image Processing for Conical Scan IR Seekers

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of conical scan IR seekers

DESCRIPTION: Significant developments have been made in image processing for optically scanned scenes. Optical processing methods have been developed for identifying and tracking objects in the presence of noise and structured background. Most of this processing is based on a raster scan of the scene which can reproduce an image. New IR seeker designs for multispectrum guidance use a conical scan of arrays of multiple detectors. The conical scan is the natural scan 2 method for these seekers.

The seeker output is in the conical scan coordinate system and often has varying, redundant sampling of the scene. The objective of this initiative is to define and demonstrate the ability to apply the mass of image processing algorithms to the conical scan seeker. Transformations of the processing algorithms and the use of the oversampled data need to be determined. The ability to use the transformed processing algorithms to detect moving targets in background scenes needs to be demonstrated. Consideration should be given to the ability to perform these algorithms on processors that can be used in missile seekers.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to define and demonstrate the ability to apply the mass of image processing algorithms to the conical scan seeker.

N91-269 TITLE: Spectral Analysis of Stray Light

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of IR seekers

DESCRIPTION: Free gyro IR seekers are being developed for multispectrum guidance that operate in the long wavelength IR spectrum. These systems are susceptible to degradation due to stray reflected and emitted light from internal and external sources. Currently, specialized computer programs exist for the analysis of stray light in static conditions. This analysis is done in the time domain. In order to evaluate the performance of the LWIR seeker, it is highly desired to perform the stray light analysis in the frequency domain. This would produce frequency spectrums for the rotating free gyro seeker. The objective of this initiative is to develop and test the capability for computer analysis of stray light in the frequency domain. The optical design for the Multispectrum Guidance Project could be used to evaluate the capability.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to develop and test the capability for computer analysis of stray light in the frequency domain.

N91-270 TITLE: RF Seeker Near Field Measurement System

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of RF seekers.

DESCRIPTION: The utilization of multispectrum guidance systems has made the measurement and evaluation of the RF antenna patterns very complex. It is desired to use near field measurement techniques to assess the interactions between the radiation element, the radome, and the IR seekers in the near field. The RF antennas are gimballed microwave and millimeter wave systems typical of current RF air-to-air guided missiles. This will allow better design of the integrated antenna system and boresight error correction. The ability to measure local area insertion phase delay and transmission loss will improve design capability. The objective of the initiative is to design and demonstrate near field measurement equipment for use in multispectrum guidance.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to design and demonstrate near field measurement equipment for use in multispectrum guidance.

N91-271 TITLE: Electronic Nutation Damping of Free Gyro Seekers

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of IR Seekers.

DESCRIPTION: Free gyro seekers like the Sidewinder have traditionally used complex mechanical dampers to reduce the oscillation of the seeker at the nutation frequency of the gyro. These mechanical designs are inherently j frequency dependent. Current designs can be improved if the gyro speed is higher and variable. This requires that the nutation damping be adjustable. Electronic damping may be possible over a range of gyro speeds. The objective of this initiative is to design and demonstrate electronic damping of a small free gyro for application to an IR seeker. The design parameters for the Multispectrum Guidance seeker will be provided for the initial design.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to design and demonstrate electronic damping of a small free gyro for application to an IR seeker.

N91-272 TITLE: Optimized Antennas for Multispectrum Guidance

CATEGORY: Exploratory Development

OBJECTIVE: Improve system performance of RF seekers with aperture blockage.

DESCRIPTION: Multispectrum seeker systems are being developed which will include a coaxial IR system mounted in the radome of a gimballed RF seeker. Presently the RF and IR seekers are developed independently and integrated into a single system. The RF antenna patterns are degraded by the presence of the IR blockage. Total system performance could be improved by designing the RF antenna for optimum average performance over all RF gimbal angles in the presence of IR seeker blockage. The objective of this initiative is the development and test of an optimized RF antenna in the presence of the IR seeker blockage. The degradation in antenna gain and sidelobes will be minimized as well as the magnitude of the boresight errors caused by the IR blockage.

Phase I: Study outlining the approach which will be undertaken to pursue requirements addressed above with sufficient data to demonstrate feasibility.

Phase II: Use the approach outlined in Phase I to design and demonstrate the ability to apply the optimization techniques to the antenna used on the Multispectrum Guidance Project.

The Naval Weapons Center SBIR office can provide information on the Multispectrum Guidance Project.

N91-273 TITLE: MPSK Synchronization Modes Study

CATEGORY: Research

OBJECTIVE: To demonstrate a differentially coded, band limited phase shift keyed signal, fed from encoder to decoder by cable, to determine lockup time, false lock, and no-lock conditions with random data and with known patterns--bit rate, carrier frequency, and number of phase states negotiable.

DESCRIPTION: Problem: In data links using phase shift keying (PSK), it is impossible to tell which of the two (or more) states of the carrier is present, only to determine the difference between them and (if there are more than two states) the direction in which the phase has "rolled". Since, on a system with three states equally spaced 120 degrees apart (optimum case), more than one "bit" of information can be transmitted by each transition. With four states (as in quadriphase shift keying [QPSK]), four possibilities exist, namely roll forward 90 degrees, roll backward 90 degrees, roll 180 degrees (direction indeterminate), and do not roll. In general, for a m-ary PSK system, the number of bits transmitted per symbol is the base-2 log of the number m.

Phase I: Conduct a study to demonstrate a system of this type, generating m phases on an RF carrier of arbitrary frequency (500 MHz to 3000 MHz region) to determine how quickly such a system can resynchronize after an

interruption with data throughput rates of 2-5 Mb/s, using random sequences and data containing fixed patterns. Such a demonstration device would not emit RF energy, since the interconnection between the encoder and decoder would be a coaxial cable.

Phase II: Develop a prototype system. This will be followed by development of the fully functional system; meeting requirements defined in Phase I.

N91-274 TITLE: QPSK and MPSK Transmission and Receiving Equipment

CATEGORY: Research

OBJECTIVE: To demonstrate a quadriphase shift (and possibly more than quadriphase) receiving and transmitting system, determine the resulting bandwidth with modulation by a random digital source, and determine characteristics for recovery/resynchronization after noise bursts.

DESCRIPTION: Problem: All digital telemetry signals to date have been sent by binary frequency shift transmission means, which is the most easily implemented and most immune to noise of all digital transmission modes. High data rates (greater than 800 Kb/s) require that the transmission occupy three, five, or more channels. (This is always an odd number because of an anomaly in the frequency management system.) Use of m-ary frequency-shift keying (where m is an integer greater than two, usually a power of two) has been investigated and found to not have the desired advantages, but phase-shift keying with m >2 seems worth investigation.

Phase I: Investigate the feasibility and approach to the problem.
Phase II: Develop and demonstrate the capability of such a system.

N91-275 TITLE: Circularly-Polarized Microstrip or Stripline Antenna

CATEGORY: Engineering Development

OBJECTIVE: Manufacture and test a single panel and/or multiple wraparound ("band aid") antenna that produces a circularly-polarized output normal to the mounting surface on a (negotiable) frequency between 1435 and 2400 MHz.

DESCRIPTION: Problem: Circularly polarized antennas are almost universally used for reception of telemetry signals, but linear (that is, not circular) polarization is used for the transmitting end. As a consequence, the receiver experiences a 3 dB loss due to the polarization mismatch thus dumping half the available signal power. Circularly-polarized antennas are also capable (when used at both ends of the link) of rejecting ground bounce and reflections.

Phase I: Explore the feasibility and approach to the problem.
Phase II: Develop and demonstrate the capability of such an antenna.

N91-276 TITLE: Burst Data Flywheel

CATEGORY: Engineering Development

OBJECTIVE: Build and demonstrate a circuit which produces a continuous, "smooth" data stream and associated clock from data received in bursts of variable length and fixed clock rates.

DESCRIPTION: Problem: Burst-mode telemetry systems accumulate data until a buffer is filled enough to make the data volume worthwhile, at which time the data is sent in the order received as a high speed burst. As a result, the received data is in bursts, which is acceptable for computers, but not for display and analysis by human observers. A data flywheel would accept the burst-type data and provide an output at a constant rate. The flywheel box would be used instead of a bit synchronizer/signal conditioner (BSSC) in a typical ground station. A reasonable capacity is 1/30 second at a maximum output rate of 5 Mb/s and an input rate of 20 Mb/s.

Phase I: A study to determine feasibility and approach to the problem.
Phase II: Build and demonstrate a prototype.

N91-277 TITLE: HORACE Data Channel Equipment

CATEGORY: Advanced Development

OBJECTIVE: Build and demonstrate a pulse code modulation (PCM) encoder and decoder for the data channel portion of a composite data and video signal in accordance with NWC TP 7025.

DESCRIPTION: Problem: The technical description of the HORACE digital television protocol (NWC TP 7025) and NWC Specifications 2421 and 2422 describe a system in which data and digitized, compressed television pictures may be combined with a high bit rate digital data stream (100 kb/s to 5 Mb/s). These documents are available from the Naval Weapons Center SBIR office.

While the protocol provides for such service, and the specification includes "hooks" for it, no such system has ever been built. A representative system would produce an encoder that operates to the standard, and an add-on card to the decoder or a free-standing box to accomplish the separation of the data in signal from the composite.

Phase I: An approach and implementation study would be required.

Phase II: Actual prototype hardware and appropriate documentation to validate Phase I and ensure compatibility with existing hardware.

N91-278 TITLE: Fast KUTA-class Encryptors

CATEGORY: Advanced Development

OBJECTIVE: Develop a hybrid or monolithic circuit which replaces the current KGV-68 data encryptor for data rates beyond 10 Mb/second and up to at least 20 Mb/second, with better standby battery voltage characteristics and more "standard" package as desirable features.

DESCRIPTION: The TSEC/KG-66, TSEC-KG-67, and hybrid TSEC/KGV-68 KUTA-class encryption devices are one-way encryption devices intended for use on telemetry links at data rates ranging from near DC to 5-10 Mb/s. The encryptor devices also form the basis for the decryptor. The KUTA-class equipment does not change the bit rate between input and output (i.e., no overhead bits are added), nor is data oriented in blocks as in some other systems. While cryptographic equipment of other types is made to operate at bit rates to 50 Mb/s and beyond, existing systems do not have the KUTA attributes and are generally far larger and run on voltages not conveniently available within an airborne environment.

Phase I: A study on a "fast" KUTA is needed to operate at bit rates up to at least 20 Mb/s, and preferably up to as high as 45 Mb/s. A proposed device would need to draw less power and retain the same size or be smaller than the existing KGV-68 device.

Phase II: Develop a prototype system and deliver to the Government the documentation package.

N91-279 TITLE: Development of Fully Automated Software Testing System

CATEGORY: Exploratory Development

OBJECTIVE: Develop software for a system that will develop and run test software and data for a given FORTRAN or Ada software module or hierarchial set of modules.

DESCRIPTION: The test software and data will be generated based on the interfaces defined in the module(s) to be tested. The system will also take test data inputs from a user. The test software and data will cover all logical paths in the software. The system will also be capable of running the test and develop test reports.

Phase I: (1) Establish detailed requirements for the Fully Automated Software Testing System: and (2) research hardware and software already available which performs this task, could be modified to perform this task, or could be used to partially satisfy the requirements for the task.

Phase II: Develop a prototype system. This will be followed by development of the fully functional system. That system will meet requirements defined in Phase I and in prototype development and evaluation. Develop and test the system in accordance with government standards.

PACIFIC MISSILE TEST CENTER

N91-280 TITLE: Telemetry Real Time Intelligent Monitoring System (TRIMS)

CATEGORY: Exploratory Development

OBJECTIVE: Develop an expert system which will aid analysts monitoring missile systems during testing.

DESCRIPTION: The Pacific Missile Test Center is designated as the lead activity for conducting development testing of various missile systems. In support of this test effort the Cruise Weapons Division, Code 1070, provides analysts for monitoring flight tests. Typically, there are many separate strip charts and real time display stations which require monitoring. The real time displays which are currently used provide someone limited red-line (i. e., potentially hazardous conditions) checking for selected measurements such as engine and electrical parameters. Related measurements are checked and conclusions are drawn from the data solely dependent on the analysts experience. The difficulty and high cost of maintaining a cadre of experienced "chart watchers" has made it apparent that an alternate solution for the effective monitoring of flight tests is required. Therefore, the requirement of this task is to explore that feasibility of incorporating expert system technology into the real time display software as an automated aid to the analysts. The challenge in this task is to develop a system that is robust enough to cross correlate related parameters and arrive at quality advisories under the conditions of noisy data, drop outs, and potentially missing parameters. Previously recorded flight test data will be provided to be used to develop and demonstrate the system. Management of this SBIR task would be accomplished in the following manner:

Phase I: Demonstrate concept on existing computer with real data.

Phase II: Determine hardware/software requirements to implement formulate POA&M to fully implement.

N91-281 TITLE: Radiation and Scattering Modeling of Microstrip Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: This study will provide a new methodology of analyzing and designing a new microstrip antenna, embedded in a dielectric substrate or layer, with minimal scattering effects which is necessarily required for T&E telemetry application.

DESCRIPTION: In the testing of new and future aircraft and weapon systems, the ability to detect and track low observable vehicles is necessary for test control, hazard assessment, and performance measurement. The tracking must not compromise the low-observable signature characteristics of the vehicle, either by added protrusions, changes in physical shape, or transmissions in the frequency of interest at the threat frequencies being evaluated. Present on-board transponders and command systems antennas may increase the radar cross section of the target system thereby degrade the performance and consequently constraining achievable test objectives. An alternate way of designing telemetry antennas with minimal backscattering effects is critically needed.

This study will provide a new methodology of analyzing and designing a new microstrip antenna, embedded in a dielectric substrate or layer, with minimal scattering effects which is necessarily required for T&E telemetry application. The analytical formulation should consider the effects of feed excitation and termination-structure. The analysis should also include the choice of antenna elements, feeds, termination shape, and material properties.

Phase I: Conduct an engineering study for investigating a new method of analyzing radiation and scattering properties of microstrip array antennas.

Phase II: Develop a computer analysis code as well as implement a prototype engineering design of a microstrip telemetry antenna with minimal scattering effect.

N91-282 TITLE: Fire Free Day/Night Signal Cartridge for Practice Bombs

CATEGORY: Advanced Development

OBJECTIVE: Develop a day/night practice bomb signal cartridge that will not start fires on bombing ranges.

DESCRIPTION: Over one million signal cartridges per year are used in practice Bombs for marking their point of impact on bombing ranges for scoring purposes. Cartridges now used are causing fires on the bombing ranges. The Military Services need a day/night signal cartridge which will satisfy the following criteria.

1) Not cause fires on bomb ranges. The static fire hazard test is as follows: the cartridge shall not produce a fire when the cartridge is fired at a distance of 3 feet +/- 1/2 foot from the end of the static test gun into the center of an excelsior target which is a minimum 2 1/2 feet square and 8 inches +/- 1 inch in thickness. The dry excelsior (PPP-E-911, Type I, Class 3B, Grade 5) shall be packed to a uniform density of 2 lbs +/- 1/2 lb per cubic foot, and be retained within a framed target to ensure that the excelsior is not dispersed by the firing of the cartridge.

2) Provide a system to instantaneously mark the impact point of the practice bombs detectible from a distance of not less than 1 mile: signal is not limited to flame and smoke.

3) Provide an emission long enough to be recorded and provide singular discrimination between succeeding impacts.

4) Provide a signal within 1.6 milliseconds of surface impact.

5) Be encased in a cylindrical cartridge 0.85 inches in diameter and approximately 6 inches long.
6) Not contain any material which is toxic, radioactive, or environmentally harmful.
7) Pass the 14 day temperature and humidity cycle of MIL-STD-331 Test 105 without exploding, leaking smoking, or case cover separation.
8) Not explode or separate when subjected to the five foot drop in which sample shall impact horizontally within +/- 15 degrees in accordance with MIL-STD-331, Test III, Procedure 2.
9) Pass the vibration test of MIL-STD-810, Method 514.2 Procedure I, Figure 514.2-2 Curve J.
10) Not significantly increase unit cost.

Phase I: The first phase will determine if a fire free day/night signal cartridge is producible and, if feasible, demonstrate by producing prototypes.

Phase II: This phase will test and evaluate prototypes.

N91-283 TITLE: Target Drone Control Via Satellite

CATEGORY: Engineering Development

OBJECTIVE: Develop a target drone which can be controlled by satellite.

DESCRIPTION: Battleforce weapons being developed for the Navy's use in the 1990-2010 period require large ocean areas for test and training operations. The shift from fixed, line-of-sight ranges to the larger open ocean areas presents particular problems for command and control of target drones. The present methods using fixed, line-of-sight data links are impractical in an operation conducted hundreds of miles from a land based facility. Studies have shown that RPV's (remotely piloted vehicles) and target drones may be controlled via satellite data links from shore based operations centers. The purpose of this project would be to design, fabricate, test and demonstrate a system that would remotely pilot a target drone or an RPV (Remotely Piloted Vehicle) over ocean areas via a satellite data link from a shore facility.

Phase I: Design and test data link and command and control system.

Phase II: Demonstrate by flight test, a remotely piloted vehicle via satellite.

N91-284 TITLE: Global Positioning Satellite (GPS) Transponder

CATEGORY: Research

OBJECTIVE: To develop transponder for GPS.

DESCRIPTION: GPS (Global Positioning Satellite) Transponder: In the near future GPS acquisition will be available on an around the clock basis, thereby, accurately conveying position, velocity, and time to the user. One application for this technology is in remotely acquired positioning via an RF link to a central location. The system would potentially operate analogous to a radar transponder, except identifying positional data when the system is interrogated. This positioning transponder system would then provide the location of all furnished units within a test range facility. The GPS system will collect all ephemeris data via the C/A code and then acquire accurate positioning with P code, both on the L band. Positional up dates through the satellites are on a time interval of tens-of-seconds, but could be increased by interpolation with velocity data. The system accuracy are built-in errors in the GPS processing and retransmission. The positioning transponder will be comprised of three subsystems, L bandreceiver, GPS processor, and a transmitter. There are three possible strategies to relaying the positional data via the transponder, interrogation, continuous, or time mutiplexed between the various systems.

Phase I: Study of potentially designing the positioning transponder (receiver, processor, and transmitter) to a minimum size, volume.

Phase II: Demonstrate actual positioning transponder hardware.

N91-285 TITLE: New Technologies for Determination of Angle of Arrival of Laser Sources

CATEGORY: Research

OBJECTIVE: To develop techniques to determine a laser threat.

DESCRIPTION: Phase I-investigate new and innovative concepts and technologies for determining Angle of Arrival (ADA) of laser sources. Emphasis should be placed on exploiting the physical properties of electro-optic (ED) materials that can be implemented in a light weight, conformal surface configuration. The technology should be capable of performing to at least the

following specifications:

Minimum Detectable Signal level: 1x10 W/cm)(Peak Power Density)
Pulse Width range: 10 to 100ns
False Alarm Rate: No more than one per hour
Probability of Detection: 95%
Angle of Arrival Resolution: + 3 Degrees

Provide indication of threat laser wavelength and pulse repartition rate. Concepts should be based on current technologies and supported by validated physical models.

Phase II-demonstrate a brassboard proof-of-concept prototype of the technology for determining ADA of laser sources presented in the Phase I effort. This is not expected to be an operational technology, but must provide an unambiguous demonstration of the theory and principle of the Phase I concept.

A description and program plan of how this technology can be implemented on an operational platform must also be provided.

N91-286 TITLE: Submarine Training Minefield Real Time Tracking System

CATEGORY: Engineering Development

OBJECTIVE: Improve fleet submarine training in mine detection and avoidance by providing the Hawaiian Area Deep Water Submarine Training Minefield with a stand-alone tracking and positioning system. Real time self track is a requisite for realistic submarine training exercises. The system would allow immediate feedback between the mine-hunting sonar operator and onboard observers, further enhancing the value of each exercise.

DESCRIPTION: The Hawaiian Area Deep Water Submarine Training Minefield is an exercise range consisting of 10 vertical arrays each containing one or two inert mineshapes. Simple acoustic transponders are located on central arrays and act as beacons for submarine safety and onboard positioning. The transponders output frequencies are detectable by the submarines's passive sonar but not by the active mine hunting sonar. The practice minefield allows for training of the mine hunting sonar operator in mine detection; the transponder permits real time review of his performance by onboard observers. Limited tracking data, manual plot methods, and ambiguities in sonar returns means the exact position of the submarine during the exercise is not precisely known, creating an inadequate training exercise. The purpose of this project is to develop a "smart" transponder and on board tracking system. When one transponder is interrogated by the submarine, it will in turn interrogated by all others in the field. Based on time delay from the transponders to each other and to the submarine, the submarine's exact position can be determined by the onboard tracking system. This would allow for training utilization of every shape in the minefield with an increase in realism and submarine safety. The onboard tracking system would include minicomputer with plotter and data storage. Feedback to the sonar operator would be greatly improved over present methods.

Phase I: Investigate available technology and application to this project.

Phase II: Assemble and test a prototype tracking system for one submarine and three exercise mineshapes.

Phase III would develop a complete system with all mineshapes instrumented, and at least three onboard tracking systems each and adaptable to particular submarine installations.

NAVAL AVIONICS CENTER

N91-287 TITLE: Multi-Frequency Personal Locator Beacon/Emergency Locator Transmitter/Emergency Position Indicating Radio Beacon (PLB/ELT/EPIRB)

CATEGORY: Advanced Development

OBJECTIVE: Develop a multi-frequency (121.5/243/406/282.8 MHz) radio beacon transmitter system as candidate replacement equipment for the AN/PRC-90(V)-2 PLB, AN/URT-33 (V) ELT and AN/PRT-S EPIRB. Integrate the 121.5/243/406/282.8 MHz frequencies into the AN/PRC-112(V) covert survival radio as the primary replacement for the AN/PRC-90(V)-2 and the AN/URT-33 (V). A need and market exists for this advanced Search and Rescue (SAR) system within DoD, NASA, FAA, USCG and foreign military/civilian agencies.

DESCRIPTION: The Multi-Frequency PLB/ELT/EPIRB should be capable of emergency radio beacon transmission on 406 MHZ (short message) COSPAS/SARSAT international emergency frequency and 121.5/243 MHZ moded (modulated swept tone/modulated morse code/unmodulated carrier wave) civilian/military frequencies. The radio beacon transmission cycle should be approximately 60 seconds with 440 ms of 406 MHz and simultaneous 121.5/243 MHz moded transmission (18 sec modulated

Morse Code, 9.6 sec modulated swept tone and 22.4 sec unmodulated pure carrier wave. The 282.8 MHZ should be a transceiver frequency for emergency voice communications. The Multi-Frequency PLB/ELT/EPIRB should meet the requirements of NATO STANAG 3281 and RTCA/DO-204, Minimum Operation Performance Standards 406 MHz Emergency Locator Transmitters (ELT), with exceptions as agreed upon by the Government Design Agencies. The system should be designed to provide maximum SAR performance, reliability, maintainability and survivability with minimum weight, volume and cost.

Phase I: Requires research and development of current and new radio beacon and communications technologies including operational requirements, standards and specifications, hardware, software and operation procedures.

Phase II: Requires full scale engineering development of prototype systems in PLB, ELT and EPIRB configurations. Test and evaluation will be conducted at the Naval Avionics Center and the Naval Air Test Center.

NAVAL ORDNANCE STATION/INDIAN HEAD

N91-288 TITLE: Degradation of Ordnance Ingredients by the White-Rot Fungus Phanerochaete Chrysosporium

CATEGORY: Exploratory Development

OBJECTIVE: To determine the applicability of White-rot fungus to decomposition of ordnance ingredients and materials.

DESCRIPTION: Phase I: Evaluation of the current status or research on Phanerochate chrysosporium for the degradation of TNT and other ordnance materials and investigation of its applicability to nitro-amines such as RDX, HMX, and nitro-guanidine.

Phase II: Investigation of possible applications to ordnance contaminated materials and sites, and to Navy waste minimization or waste disposal.

N91-289 TITLE: Processing of Energetic Materials with Supercritical Fluids

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel processing techniques for energetic materials.

DESCRIPTION: Research and development of process methods for energetic materials using supercritical and critical fluid technology. Ball-grain powder, pelletized nitrocellulose, high bulk nitro-guanidine (NQ) and 1,3,5,7 Tetranitro -1,3,7-tetrazocine (HMX) are produced by processes developed twenty to forty years ago. Supercritical fluid technology with its excellent solvating character offers unique opportunities for the development of novel processing techniques for energetic materials.

Phase I: Investigate the extraction of components from obsolete propellants and explosives and produce new products from the recovered ingredients. The new products would be spherical particles of nitrocellulose, nitro-guanidine and HMX.

Phase II: Will emphasize the optimization of the processing technology and the development of a prototype demonstration to verify the validity of the techniques. The demonstration must also show the viability for scale-up for practical application should the project transition to Phase III.

N91-290 TITLE: Removal of Combustion Gases Produced from the Thermal Treatment of Propellants from Small Rocket Motors Utilizing Gas Scrubbers

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate and develop gas scrubbers to remove gaseous combustion products generated from rocket motor lot acceptance testing, the demilitarization of small rocket motors, and the burning of scrap generated during propellant processing.

DESCRIPTION: The contractor is to develop state-of-the-art gas scrubbers to remove gases generated during rocket motor Lot Acceptance Testing, the demilitarization of small rocket motors by thermal treatment, and the burning of scrap generated during propellant processing. Specific gases to be removed include hydrochloric acid, oxides of aluminum, and oxides of nitrogen. The concentrations of these gases are to be reduced to an environmentally acceptable level before venting to the atmosphere. Contractor should be aware that the combusting propellant produces large quantities of gases at very high temperatures.

Formulations of the propellants to be thermally treated are classified, therefore personnel must meet appropriate security requirements.

Phase I: Contractor shall provide a small scale working gas scrubber that reduces the concentration of mixtures of hydrochloric acid, oxides of aluminum, and oxides of nitrogen to an environmentally acceptable level. A final reportshould be provided with sufficient data to demonstrate feasibility.

Phase II: Continue development of the gas scrubber with modifications and appropriate scaling to handle actual burning propellants. Gas concentrations should be reduced to an environmentally acceptable level. Results of these tests are to be reliable and reproducible.

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Systems Command Deputy Chief of Staff for Technology. The Air Force SBIR Program Manager is R. Jill Dickman. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of the Air Force
HQ AFSC/XTXC (SBIR Program Manager)
Andrews AFB DC 20334-5000
(301) 981-5675

Do NOT submit a SBIR proposal to the AF SBIR Program Manager under any circumstances.

NO additional technical information (this includes specifications, recommended approaches, and the like) can or will be made available by the Air Force during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to section 7.1 in this solicitation for further information on DTIC.

All Air Force topics seek innovative solutions to the enumerated problems. Any level of R&D, whether Basic Research, Exploratory Development, Advanced Development or Engineering Development will be considered appropriate for any topic.

Send one original red and four (4) copies of each Phase I proposal and three (3) additional copies of appendices A and B to the office designated below:

TOPIC NO	ACTIVITY/ADDRESS
AF91-001 thru AF91-019	MSD/PKL (SBIR Program Manager) Bldg 13, Rm 258 Eglin AFB FL 32542-5434
AF91-020 thru AF91-024	AEDC/PKP Bldg 100 Arnold AFB TN 37389-5000
AF91-025 thru AF91-030	ESD/XTP (SBIR Program Manager) Hanscom AFB MA 01731-5000
AF91-031 thru AF91-050	RADC/XPX (SBIR Program Manager) Bldg 106, Rm B-109 Griffiss AFB NY 13441-5000
AF91-051 thru AF91-058	HQ AFESC/RDXM (SBIR Program Manager) Bldg 1120 Tyndall AFB FL 32403-6001
AF91-059 thru AF91-070	HSD/XART (SBIR Program Manager) Bldg 1155 Brooks AFB TX 78235-5000
AF91-071 thru AF91-071	ASD/AEE (SBIR Program Manager) Area B, Bldg 57, Bay 10 Wright-Patterson AFB OH 45433-6503
AF91-072 thru AF91-078	ASD/AEF (SBIR Program Manager) Area B, Bldg 15, Rm 043 Wright-Patterson AFB OH 45433-6503
AF91-079 thru AF91-082	ASD/XRX (SBIR Program Manager) Area B, Bldg 56, Bay 10 Wright-Patterson AFB OH 45433-6503
AF91-083 thru AF91-083	4950th Test Wing/DOMM (SBIR Program Manager) Area C, Bldg 4010, Rm 15 Wright-Patterson AFB OH 45433-6513
AF91-084 thru AF91-093	WRDC/AAOP (SBIR Program Manager) Area B, Bldg 22, Rm S-110 Wright-Patterson AFB OH 45433-6543
AF91-094 thru AF91-100	WRDC/ELA (SBIR Program Manager) Area B, Bldg 620, Rm C2069 Wright-Patterson AFB OH 45433-6543
AF91-101 thru AF91-108	WRDC/FIOP (SBIR Program Manager) Area B, Bldg 45, Rm 219 Wright-Patterson AFB OH 45433-6543

AF91-109 thru AF91-111	WRDC/KT (SBIR Program Manager) Area B, Bldg 146, Rm 122 Wright-Patterson AFB OH 45433-6553	
AF91-112 thru AF91-127	WRDC/MLIP (SBIR Program Manager) Area B, Bldg 653, Rm 406 Wright-Patterson AFB OH 45433-6533	
AF91-128 thru AF91-139	WRDC/POMX (SBIR Program Manager) Area B, Bldg 18A, Rm A-103 Wright-Patterson AFB OH 45433-6563	
AF91-140 thru AF91-140	WRDC/TXAD (SBIR Program Manager) Area B, Bldg 45, Rm C02 Wright-Patterson AFB OH 45433-6523	
AF91-141 thru AF91-141	HQ AFSTC/XNE (SBIR Program Manager) Bldg 497 Kirtland AFB NM 87117-6008	
AF91-142 thru AF91-147	*AFSTC OLAB (SBIR Program Manager) PO Box 92960 Los Angeles AFB CA 90009-2960	*Hand Delivery accepted AFSTC OLAB, Bldg A2, Rm 2213B 2350 East El Segundo Blvd El Segundo CA 90245
AF91-148 thru AF91-155	AL/TSTR (SBIR Program Manager) Bldg 8353, Rm 116B Edwards AFB CA 93523-5000	
AF91-156 thru AF91-162	GL/XOP (SBIR Program Manager) Bldg 1107, Rm 240 Hanscom AFB MA 01731-5000	
AF91-163 thru AF91-169	WL/PRC (SBIR Program Manager) Bldg 413, Rm 147E Kirtland AFB NM 87117-6008	
AF91-170 thru AF91-173	WSMC/XP (SBIR Program Manager) Bldg 7015 Vandenberg CA 93437-6021	
AF91-174 thru AF91-188	BMO/MYSP (SBIR Program Manager) Bldg 523, Rm 305 Norton AFB CA 92409-6468	
AF91-189 thru AF91-196	*AFOSR/XOT (SBIR Program Manager) Bldg 410, Rm 216 Bolling AFB DC 20332-6448	*Hand Delivery accepted after calling ahead to 767-4969
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AIR FORCE INDEX

DEPARTMENT OF THE AIR FORCE

FY 1991 TOPIC DESCRIPTIONS

AF91-001 TITLE: Armament Research

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable conventional munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered non-nuclear munitions and armaments. These include energy sources and conversions, bombs, submunitions, warheads, projectiles, fuzes that include safe and arm devices for air-to-air missiles, dispensers, rockets, sensors and seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, and lethality and vulnerability assessment techniques. Some examples of desired research are low drag/observable weapon airframes; conformal ejector racks; high-voltage storage-and-switching techniques; compact, short-term, cryogenic cooling for passive IR fuzing; millimeter wave-seeker's/sensors for mid-course and terminal guidance; heavy metal self-forging fragment warheads; heavy-metal shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid-generation techniques, and warhead hydrocode-assessment techniques.

AF91-002 TITLE: Innovative, Electromagnetic-Launcher Concepts

OBJECTIVE: Explore and combine new technologies to enhance existing electromagnetic launcher (EML) capabilities.

DESCRIPTION: Innovative concepts to advance the technology of hypervelocity electromagnetic launchers should be directed toward the following: 1) lightweight technology (especially projectiles); 2) mega ampere switching (opening and closing switch technology); 3) directional control concepts for distribution of electrical and thermal currents (advanced concepts required for armatures and projectiles); 4) energy recovery; and 5) high strength-to-weight electromagnetic launchers. Continuous development of key technology areas are required to address critical issues (e.g., velocity limitations caused by inbore rail damage) which limit the performance and efficiency of electromagnetic launchers. The knowledge to be gained will be assessed with regard to the use of advanced materials and structural designs, especially the compatibility of the armature and/or the projectile with the rail conductors. The knowledge also will be evaluated by the capacity to obtain more reliable measurements to better establish the maturity and performance potential of EMLs, and by the feasibility of merging new technology with system requirements. Phase I should focus on expanding existing knowledge of EMLs and should provide recommendations as to how this increased knowledge will advance the state of EMLs. Phase II should incorporate hardware or experimental demonstrations resulting from the concerns defined in Phase I. Phase III should produce prototype devices that will advance technology applicable to space based EMLs in areas such as platform mass, cooling requirements, and system efficiency.

AF91-003 TITLE: Microwave-Monolithic-Integrated-Circuit (MMIC) Technology for Air Target Fuzing

OBJECTIVE: Develop MMIC technology to integrate the components of a radio-frequency (RF) proximity sensor for missile fuzing.

DESCRIPTION: Radio-Frequency (RF) technology has historically been the technology of choice for all-weather air target missile fuzing. In order to achieve 360 degrees azimuthal coverage without access to the missile frontal area, RF fuze systems have employed complex, expensive duplexers, circulators, power dividers/combiners and RF plumbing between the single transmitter/receiver module and remote antennas. The Air Force Armament Test Laboratory (AFATL) is interested in innovative techniques of applying MMIC technology to the problem of air target fuzing. To support the guidance function, future air target missiles will include significant signal processing which can also be utilized by the fuzing system. Recent investigations into azimuthal-target location by air-target fuzing offer a potential solution to the "early bird/late bird" problem and the option to employ aimable/directional warheads. However, these advances entail increased fuze design complexity and cost. The technical challenge is to apply MMIC technology to transmit/receive (T/R) modules and conformal patch antennas which would individually cover a segment (60 degrees to 90 degrees) around the missile. The individual modules should be centrally controlled, provide azimuthal-target resolution, and eliminate most, if not all RF, plumbing. Phase I will include the analysis and design of MMIC components for a missile proximity fuze. Component designs should then be integrated into an overall system concept. Phase II would include integration, fabrication and demonstration of the conceptual designs from Phase I to show proof-of-concept. Phase III would include extension of the demonstrated concept to advanced missile fuzing with possible commercial application in transportation and shipping sensors.

AF91-004 TITLE: Electronically Scanned, Reconfigurable, Millimeter-Wave (MMW) Antenna

OBJECTIVE: Develop a skin-embedded, low-radar-cross-section (RCS), reconfigurable, electronically scanned, antenna system.

DESCRIPTION: Work is currently being pursued in the area of Smart Skins technology. Smart Skins systems will reduce the weight and volume consumed by avionics systems and enable the airframe designer to maximize the airframe performance while providing an avionics system which is capable of monitoring its health and compensating for damaged or failed avionics systems. Advances being brought about by the Smart Skins technology for aircraft must be exploited by armament designers to produce weapon delivery systems which are low drag, lightweight, optimized for airframe size, capable of operating at speeds above Mach 1, and low-cost. The technical challenge is to develop a low RCS electronically scanned antenna embedded in the skin of a missile/weapon airframe. The antenna will be scannable in 2 dimensions and operate at 35/94 GHz. Additionally the antenna will be reconfigurable to optimize the available antenna aperture for low RCS and to offset element damage or component failure. Phase I is to analyze and design the antenna and associated electronics to satisfy the above requirements. An analysis of the electrical and structural properties of the materials will be conducted. This phase will culminate in a recommendation of antenna design, skin material, and associated electronics. Phase II includes the fabrication and embedding of the antenna and associated electronics into the proposed skin material. Tests will be conducted to characterize antenna performance, demonstrate the ability to scan in two dimensions and validate the structural integrity of the skin material. Antenna elements will be altered through manual or mechanical means to demonstrate RCS reduction potential and reconfigurability. Phase III will produce the software required to reconfigure the antenna for RCS reduction and to optimize performance in the event of damage or component failure. Such an antenna will also have direct application in the obstacle avoidance systems of automobiles and sensors for automatic doors.

AF91-005 TITLE: Pressure/Temperature Shock-Wave Sensor

OBJECTIVE: Develop a sensor to measure temperature and pressure in the reaction zone of an explosive.

DESCRIPTION: The reaction zone of a detonating explosive has not been well characterized. Some work has been done on the theory of how an explosive is initiated (hot spot theory). To date, very little experimental data to validate these models exist because of the extreme environment of the detonation front. A shock front sensor that can measure both the temperature and pressure of the detonation is needed. This sensor needs a response time of 1 nanosecond or better and must survive in the explosive environment for up to 2 microseconds. The sensor must measure pressure up to 500 kilobars with a resolution of $\pm$ 10 kilobars. The sensor must measure temperatures up to 3000°C with a resolution of $\pm$ 50°C. Finally, the sensor must be small, be able to be cast in an explosive charge or attached to an external charge surface, and must be relatively inexpensive. Phase I will include analysis and selection of possible design approaches to a detonation shock wave pressure/temperature sensor. Fabrication and small scale testing would be completed to make appropriate design changes and recommend a design concept for development in Phase II. Phase II includes final design and fabrication of the selected concept from Phase I. Full scale testing on explosive charges and validation using empirical or other available data would be conducted.

AF91-006 TITLE: Three-Dimensional, Aerodynamic, Flow-Field-Analysis Animation

OBJECTIVE: Design and develop an interactive data reduction and visual representation tool for aerodynamic databases.

DESCRIPTION: Wind-tunnel experiments over the past few decades have generated aerodynamic data for a multitude of configurations. These data bases, due to their magnitudes, have gone largely untapped. In addition, with the maturation of computational-fluid-dynamic (CFD) techniques, the size of this valuable database continues to grow. Current analysis techniques are based primarily on out-of-date engineering procedures. These methods do not fully utilize the capabilities of graphic workstations for interpreting and rendering a three-dimensional database. The goal of this task is to develop an interactive, graphical, analysis tool which will aid the researcher to investigate the results of these large databases. The technical challenge is to exploit graphical tools for rendering the steady and unsteady properties of the databases in three dimensions. Phase I will develop volume rendering techniques and demonstrate their applicability to a representative subset of steady, three-dimensional, aerodynamic data. The techniques will embrace state-of-the-art capabilities in volume rendering and develop novel applications of such techniques to allow the researcher to visualize a full, three-dimensional flow field. To define visually the major flow structures, the techniques will enhance specific flow properties in the flow field. Some examples of applications are a volume rendered image of a three-dimensional flow field with translucency tied to the density and the use of ray tracing techniques to simulate Schlieren photography. The graphics software must be designed to handle general (unstructured) flow-field data bases. Phase II will produce a user-friendly, graphically interactive analysis tool for an unsteady, time-dependent, three-dimensional, flow field. It will aid the researcher through levels of automated analysis in locating areas of interest in the flow field such as high

gradient locations, shocks, asymmetry, etc., with less automation for the experienced researcher and more for the novice. The volume rendering techniques of Phase I will expand to exploit the capabilities of the chosen graphics hardware for the complete set of unsteady, three-dimensional, flow properties, still maintaining the completely general flow-field structure. Phase III effortswill develop the required hardware and/or software to port the resulting graphics analysis tool for aerodynamic flow fields to various popular graphics hardware stations. This effort will culminate in an off-the-shelf product which is easily installed and operated.

AF91-007 TITLE: Interpenetrating-Polymer-Network (IPN) Capacitors

OBJECTIVE: Examine combinations of polymers resulting in stable, lamellar, IPN, exhibiting capacitive behavior.

DESCRIPTION: In the past, development efforts have been undertaken to improve the state of the art in low-voltage, high-energy density capacitors. Compact, high-capacitance, double-layer capacitors have been developed to enhance our ability to store low-voltage electrical energy for fuzing. The charge storage mechanism for these devices stems from the small-scale morphology of the electrode coatings employed. Specifically, jagged surface anomalies on the order of twenty atomic diameters in size are responsible for the electrode's high surface area which, in turn, gives rise to large capacitance density (up to 1 F/cm^2). Mobile ions within the electrolyte concentrate along the electrode surface so that charge is stored in response to an applied voltage. In theory, an IPN interface has extremely high surface area and could be adapted to high-density charge storage; double-layer capacitors can be envisioned from this standpoint. However, to permit repeated charging and discharging, the two polymers (the doped conductive polymer electrode and the ionically conducting polymer electrolyte) must be compatible over the applied voltage range. Phase I includes an evaluation of physical and chemical properties of available conductive polymers and polymer eletrolytes which result in a set of candidate IPN combinations which appear most promising for high energy density capacitors. A subsequent Phase II would further refine the dopant chemistry and consider the interactive effects of polymer electrode and electrolyte through detailed experimentation. IPNs would be fabricated and demonstrated.

AF91-008 TITLE: Recrystallization of 1,3,5-Triamino-2,4,6-Trinitrobenzene (TATB) Using Supercritical Fluid Technology

OBJECTIVE: Develop a recrystallization process for TATB producing various particle sizes using supercritical fluid technology.

DESCRIPTION: 1,3,5-triamino-2,4,6-trinitrobenzene (TATB) is a desirable ingredient in explosive formulations because of its shock insensitivity, thermal stability and high energy. TATB is insoluble in solvents such as acetone, water, and ethanol. It is only slightly soluble in others such as aniline, dimethylsulfoxide (DMSO), and dimethylformamide (DMF). The most common solvent used to recrystallize TATB is concentrated sulfuric acid, ~20% (W/V). It is also difficult to produce TATB crystals larger than 50 microns which is why it is primarily used in pressed charges. TATB could be used in high-solids, melt, cast systems if the particle size distribution could be increased to 150-250 microns. It has been demonstrated that supercritical fluid (SCF) technology can be used to recrystallize explosives in various shapes and sizes. These fluids also possess the ability to dissolve the solvents whether on the surface of or occluded within the crystal. Recrystallized particles are then recovered dry. The goals of Phase I are to 1) demonstrate the feasibility of using super critical fluid technology to recrystallize TATB: 2) produce and deliver 200 grams of TATB in the particle size range of 150 to 250 microns; and 3) prepare an economic assessment of the process. The Phase II program goals are to 1) scale up and optimize the recrystallization process of TATB; 2) produce and deliver 100 pounds of 150 to 200 micron TATB for small-scale tests; and 3) prepare a process flow chart and an economic assessment.

AF91-009 TITLE: Portable, Miniaturized, Aerosol, Particle-Measuring System

OBJECTIVE: Develop a miniaturized, remote, particle-measuring system to better define real-time cloud physics.

DESCRIPTION: A great deal of effort has been expanded in developing particle measuring systems to better define the properties of aerosol clouds. These systems tend to be large in size, therefore intrusive in the actual flow field. The technical challenge is to develop a miniaturized remote sensor with a range of two microns to 5mm which could be easily placed in areas such as inside engine inlets. This would greatly enhance the evaluation of aircraft icing problems. This measuring system would also have application to cloud physics, leading toward more precise weather forecasting. Phase I is to conduct an analysis to determine the feasibility of such a system and to propose measuring techniques and hardware concepts best suited for this application. In Phase II the recommended prototype system design from Phase I will be fabricated and thoroughly tested with emphasis placed on ease of use, accuracy, reliability, miniaturization, and remote capability.

AF91-010 TITLE: Laser-Beam Steering Device (LBSD)

OBJECTIVE: Develop a nonmoving electronically controlled scanner for steering laser beams of active infrared (IR) seekers.

DESCRIPTION: Current active IR image seekers use moving optical devices to steer the laser beams and to generate recorded images. Rotating prisms and the Kennedy scanner are two examples. The push-broom, active, IR seekers use the airborne vehicle motion in conjunction with moving optics to generate scanning patterns. These steering methods require unwanted weight, slow scanning rates and costly precision mechanisms for pointing accuracy. The technical challenge is to investigate and develop anonmoving, electronically controlled, beam-steering device that can steer the laser beam and the returned image signal in a scanning pattern. The beam steering device shall scan a field of view (FOV) of + and - 45 degrees in both azimuth and elevation, and steer a 10-watt long wave infrared (LWIR) CO2 laser beam. In this project, all other components such as the lasers, detectors and lenses shall be off-the-shelf items. Phase I will include the investigation, analysis, and design of a candidate laser beam steering device. Characteristics of typical, active, IR, image systems shall be used in determining the beam steering device surface area and the instantaneous FOV. The beam steering device characteristics such as reflectivity, transmitivity, power absorption, and surface linearity will be defined. The output from Phase I will be a complete, prototype, laser-beam, steering-device design. Phase II will include the fabrication and testing of the LBSD designed in Phase I. Performance characteristics such as scanning rates and pointing accuracy for various levels of laser power and modes will be determined through testing. The ability of the scanner to generate returned scanned images will also be demonstrated.

AF91-011 TITLE: Near-Field, Radio Frequency (RF), Hardware-In-The-Loop (HIL) Simulation

OBJECTIVE: Explore new techniques for testing RF seekers, and develop a prototype HIL simulator.

DESCRIPTION: Guided weapons are becoming more sophisticated and costly to develop. Hardware-in-the-Loop (HIL) simulation offers an efficient and cost effective method for emulating targets, backgrounds, and engagement scenarios and for developing, testing, and evaluating seeker hardware and software. At microwave and millimeter wave frequency bands, large anechoic chambers are required to test seekers in the far field of the seeker's antenna. These chambers are expensive to build and maintain.

The goal of this program is to develop and implement techniques for testing microwave and millimeter wave seekers in an HIL simulator in the very near field of the seeker's antenna. Testing RF seekers in the near field means that much smaller chambers could be used. This would greatly reduce the overall cost of RF HIL simulator systems. The technical challenge is to develop a technique that would simulate a far-field condition to a seeker being tested in the near field. If successful, the target antenna array could be located as close as 50 to 100 wavelengths from the seeker. For a typical X-band seeker, the anechoic chamber focal length would be 5 to 10 feet instead of the 40 to 50 feet required today. Phase I would define simulation test requirements for microwave and millimeter seekers, investigate techniques and concepts for HIL simulation testing on these seekers in the very near field, and recommend candidate techniques to be pursued in Phase II. Analytical evaluations will be performed on each candidate technique as part of Phase I. Phase II would demonstrate performance of candidate techniques by developing hardware and software models performing proof-of-principle testing in a controlled environment, and collecting and analyzing test data. The models will be used to develop specifications and a design for a prototype system. Phase III is expected to produce a prototype HIL simulator that will demonstrate the total system concept of performing HIL simulation tests on a seeker in the very near field.

AF91-012 TITLE: Infrared/Radio-Frequency (IR/RF) Sensor Data Fusion

OBJECTIVE: Develop sensor level data fusion for infrared (IR) and radio-frequency (RF) sensors.

DESCRIPTION: A promising trend for future, tactical, missile guidance is the employment of dissimilar sensors to complement the characteristics unique to each. An issue arising from this trend is how to combine or fuse information from various sensors so as to optimize acquisitions and tracking capabilities of the missile. Initial studies have indicated benefits occur when the fusion process occurs at the sensor level rather than later in the signal processing chain. Separately, microchip processor technology has developed sufficiently to support requirements for real-time data fusion. As sensor data fusion technology continues to progress, signal processing architectures adapted to data fusion with specific sensors will likely be developed for tactical missile guidance. The goal of this task is to develop technology for fusing data from two dissimilar sensors, preferably radar and infrared as used for acquisition and tracking in air-to-air missiles. The intent is to accomplish data fusion by operating on sensor signals that have been processed as little as possible or, preferably, not at all. The technical challenge is to demonstrate feasibility and then develop the techniques of establishing a single track file from data as near to the sensor level as possible. Two dissimilar sensors configured on a common platform are to be used. The thrust of Phase I is to demonstrate the sensor-level data-fusion concept

and verify its advantages over multi-track file fusion. Algorithms employed in the demonstration should be as simple as possible and algorithm development kept to a minimum. Sensor-level data of simultaneous radar and infrared scenes may be simulated although real data with clutter is desired. In Phase II algorithms will be expanded and refined as appropriate. Extensive comparative analysis of sensor-level data fusion and processed data fusion will be accomplished to determine the relative performance of each. Tests and analysis will be performed on the best sensor data set available. Phase II tasks will also include designs of the processor architecture necessary to implement sensor level data fusion in tactical missiles. Phase III will involve completion of the fusion processor design started in Phase II and assembly of breadboard processor hardware. The breadboard processor with radar and infrared sensors will then be installed in either a tower or an aircraft for further demonstration and test.

AF91-013 TITLE: Surfactants for Plastic-Bonded Explosives (PBX) and TNT-Based Systems

OBJECTIVE: Identify and characterize candidate surfactants for use in explosives processing.

DESCRIPTION: Plastic-bonded explosives (PBX) consist of an explosive filler material combined with an inert polymer binder. For increased energetic performance, it is desirable to minimize the binder content. However, too little binder may result in a mix consistency that is unprocessable. A surfactant is needed, therefore, to act as a wetting/dispersing agent. This allows a reduction in binder content without a subsequent decrease in processability. The candidate surfactants must be compatible with typical PBX components, as well as with the hydroxyl-terminated polybutadiene (HTPB) binder itself. In addition, the surfactants should neither adversely affect the mechanical properties of the binder nor hinder the curing process. Melt cast systems, on the other hand, present problems not encountered in PBX mix casting. These formulations consist of an explosive granular filler suspended in molten TNT. The TNT then serves as the binder when solidified. The need for increased solids content result from performance and/or shock sensitivity requirements. Thus, the problem of maintaining homogeneity of the suspended solids needs to be addressed. Lecithin is currently used for this purpose. However, because lecithin is not readily soluble in TNT, a replacement surfactant is needed to act as a dispersing/suspending agent. The surfactants must be compatible with typical melt-cast components and they should not have a detrimental effect on the mechanical properties or the solidification process of the TNT binder. Phase I consists of a search for various surfactants to improve the processing mentioned. For each application (mix and melt cast), candidate surfactants will undergo compatibility tests with the individual components, and effects on the mechanical properties of the binders will be determined. Phase II will consist of a complete characterization of potential surfactants for mix and/or melt cast applications. Further compatibility testing will be performed with actual explosive formulations. Finally, processing studies will be conducted to determine the effectiveness of the candidates with respect to the relevant, explosive, formulation characteristics.

AF91-014 TITLE: Extremely-High-Frequency (EHF), Millimeter-Wave, Transmission Devices

OBJECTIVE: Develop efficient, active, 140GHz and 220 GHz, millimeter-wave components.

DESCRIPTION: Recent advances in solid-state-device technology, permitting the generation and amplification of signals at extremely high frequencies and at usable power levels, have prompted renewed interest in potential EHF applications. Of particular interest are those applications which can exploit the millimeter-wave transmission windows existing at 140 GHz and 220 GHz. The last significant Government-sponsored investigation and development of millimeter-wave components suitable for operation at the upper millimeter wave frequencies took place circa 1980 -1983. That investigation addressed primarily the task of passive component development. In contrast, this development concerns solid state implementation of active components specifically designed for 140 GHz and 220 GHz transmitter/receiver applications. During Phase I, candidate, solid-state, heterojunction, bipolar transistor (HBT) and pseudomorphic-high, electron, mobility transistor (P-HEMT) devices will be assessed and designed. Millimeter wave components employing these devices will be proposed for detailed Phase II design and development at each of the two frequencies, 140 GHz and 220 GHz. During Phase II the most promising components for each of the two frequencies will be fabricated and completely characterized. It is expected that this solicitation will encourage further upper-millimeter, wave-frequency, component development leading to an extremely broad range of military and commercial applications. As typical examples, Phase III could address cellular telephone (commercial), imaging millimeter wave radar (commercial/military), or terminal guided weapons (military).

AF91-015 TITLE: Free-Flight Flow-Field Measurements

OBJECTIVE: Determine the density flow field around free-flight ballistic models using interferometry reduction procedures.

DESCRIPTION: Interferometry techniques are presently used in the Aeroballistic Research Facility, Eglin Air Force Base, Florida, to validate computational-fluid-dynamic (CFD) calculations of free-flight models. These interferograms provide a

photographic image of the density fields around and in the wake of the models. The qualitative comparisons between the CFD calculations and experimentally obtained interferograms are accomplished by integrating the density fields from the CFD calculations and comparing these with the interferograms. A technique is desired which will directly obtain the experimentally measured density fields from the interferograms and thereby provide a quantitative result for comparison with the CFD calculations. The basic interferograms will be provided to the contractor. Phase I task will demonstrate digitization procedures and develop/propose a topography algorithm that can be used with the digitized interferograms to determine the density field. The most promising technique will be selected for Phase II. Phase II will take the provided interferograms and develop and demonstrate the complete reduction routine culminating in experimentally measured density fields around free flight objects and will establish this process/technique as a permanent capability at the Aeroballistic Research Facility. Phase III will establish the technique and system for commercial applications associated with other ground test facilities.

AF91-016 TITLE: Zooming Infrared Optics (ZIRO)

OBJECTIVE: Develop zooming optics for infrared guided munitions.

DESCRIPTION: Recent developments in optical processing have yielded very robust optical filters that can correlate objects that change in aspect but not scale. The dependence of optical filters on the image size is well documented. The goal of this task is to investigate methods which minimize the range dependence of optical filters by changing the optical train or modifying an element in the optical train to maintain a constant image size as the range decreases. The technical challenge is to develop the optics capable of providing a continuous zoom capability. The optics must fit in a ten centimeter hemisphere and be capable of operating in the high "g" environment (30g's axial, 60g's lateral) of conventional missiles. Phase I will investigate and develop several, continuous, zooming, infrared, telescope concepts using non-traditional design methods and components. The Phase I study should include (but, not be limited to) a determination of the ability of a monolithic micro-mirror array to act as the zooming element in the optical path of a zooming infrared telescope. All of the concepts developed will allow for computer control of the zoom. The two most promising candidate designs will be chosen for further study, including a determination of the theoretical optical limits of each concept. Potential optical materials and fabrication techniques will be recommended. In Phase II the concept designs chosen in Phase I will be fabricated in breadboard and tested. Theoretical and practical image quality will be determined through simulation. The effects of the high "g" missile environment on the designs will be determined. A final design will be recommended based on the results of testing. Phase III is expected to include the manufacture of the final design and application to missile seeker optical correlation.

AF91-017 TITLE: Two-Dimensional, Electronically Steerable, Monopulse, Millimeter-Wave (MMW) Antenna

OBJECTIVE: Develop a two-dimensional, electronically steerable, monopulse, millimeter-wave (MMW) antenna for air-to-air missile seekers.

DESCRIPTION: One-dimensional electronically steerable, MMW antennas have been developed, but they are not suitable for the dynamic environment of air-to-air missile engagements. MMW phase-shifter and gain-control component technology has improved sufficiently so that two-dimensional electronic-beam steering is now feasible. Two-dimensional, electronically steerable, monopulse antennas, capable of handling high scan rates without the use of gimbal systems, would greatly enhance the performance of air-to-air missiles. Moreover, the use of an MMW radar in air-to-air scenarios significantly reduces susceptibility to counter-measures and increases the probability of kill because of higher-guidance angle accuracies. The technical challenge of this project is to develop the low-cost components needed to construct a two-dimensional, electronically steerable, MMW monopulse antenna sized for an AMRAAM class missile. The challenge also includes the development of a monopulse feed network to output the sum, delta azimuth, and delta elevation channels. Recent developments in size reduction and increased power output of MMW solid-state transmitters provide the technology base. Phase I includes analysis and design of the antenna and monopulse feed network suitable to implement MMW antennas with beam-steering circuitry. Phase I will culminate with the recommendation of a candidate approach to incorporate the MMW components into the antenna and feed network design to be demonstrated in Phase II. Phase II includes the laboratory demonstration of the components of the two-dimensional, electronically steerable monopulse MMW radar antenna designed in Phase I. The demonstration should accomplish two-dimensional beam steering. Phase III is to produce a prototype antenna sized to fit an AMRAAM-class missile. This antenna would have to be capable of electronically steering the beam in two dimensions and be capable of handling output power loads of 250 watts average.

AF91-018 TITLE: Location and Identification of Unexploded Ordnance

OBJECTIVE: Develop sensors for locating, identifying, displaying and determining arming status of unexploded ordnance.

DESCRIPTION: Airfield attack munitions continue to improve in terms of sophistication, intelligence, variety, and effectiveness for denying the generation of aircraft sorties. After an enemy attack, a key determinant of air-base recovery is the location and identification of unexploded ordnance, including time-delayed or influence-fuzed bombs, runway penetration munitions, and scatterable air-delivered mines/submunitions. This task must be accomplished before a minimum operating surface can be selected and Explosive-Ordnance-Disposal (EOD) personnel can conduct render-safe operations against the unexploded ordnance. Presently the location and identification is primarily a visual ground or helicopter operation which is time consuming and subjects personnel to great risk. The fundamental goal of this effort is to develop a system that can locate, identify, display and determine status of unexploded ordnance used against both paved and unpaved surfaces. These actions must be accomplished accurately and in a short period of time. The technical challenge is the development of a system that can discriminate a variety of munitions differing in size and shape that may be buried or partially buried, and also operate under adverse weather conditions during both day and night operations. Phase I would include the analysis and design of the critical sensor concepts required for air-base recovery. Studies and analysis prior to design should include evaluation of the variety of munitions, technical risk, operational requirements complexity and cost. Phase I should culminate in a recommended design concept to be tested in Phase II. Phase IIincludes the development of critical components culminating in laboratory tests of sensing concepts and the bench testing of critical information processing and display techniques. Phase III would include the fabrication of a prototype demonstration/ validation system for field trials. Data from the field trials would be utilized in preparing the system level specification for follow-on full-scale development.

AF91-019 TITLE: Process Development for Uniform-Response Lead-Sulfide Detectors

OBJECTIVE: Develop a manufacturing process leading to production of uniform-response PbS detectors.

DESCRIPTION: Historically PbS detectors have been manufactured by a wet chemical deposition of PbS onto sapphire substrates having a delineated Ti/Au pattern. The final step sensitization involves heat-treating the PbS film in air. The existing processing leads to the production of PbS detectors lacking uniform detector performance not only from different PbS depositions, but also from within a deposition batch. Certain applications have a requirement for a large number of detectors exhibiting uniform response across each detector as well as from detector to detector within a quadrant. Many parameters affect the deposition process such as concentrations of oxidant, lead acetate, and thiourea/thioacetamide; substrate finish; reaction temperature; and impurities. The technical challenge is to investigate and analyze unknown effects of process parameters such as crystal orientation, crystal size, sensitization methods, film formation, etc. and then develop a process leading to unform response detectors. Phase I includes the investigation and analysis of process parameters used to produce PbS detectors. The investigation should explore the effects of process parameters or detector uniformity and recommend a process which will produce the desired detectors. Phase II will include selection of the most likely method to produce consistently uniform detectors of the preferred particle size and to demonstrate in a laboratory environment that uniform, high-yield detectors can be achieved. Phase III will include the development of prototype equipment which can produce detectors at realistic production rates

AF91-020 TITLE: Aerospace, Ground, Environmental, Simulation Testing

OBJECTIVE: Develop advanced test and evaluation techniques, instrumentation and facilities.

DESCRIPTION: New and innovative ideas and concepts are needed to develop facilities, methods and techniques to accomplish testing needed to meet requirements for aerodynamic, propulsion, space, and reentry testing. Simulation of aerodynamic flight conditions in large test facilities is a very expensive and technically challenging endeavor. Means of generating the flow conditions, the test technique and the measurement of performance and flow parameters is of interest. One specific example of a technical need is a method to heat and contain air on a large scale for true temperature conditions for testing at hypersonic flight conditions. Some additional examples of needs are aircraft/store separation, transonic wall interference, viscous simulation, turbulence measurement, boundary layer diagnostics, diagnostics of high enthalpy flows, hypersonic nozzle design and throat heat transfer, and real gas computational analysis. Additional examples of areas of desired research are aerostructural, aerothermal, and propulsion testing in ground facilities. Generation of the test environment, measurement of the test conditions, analysis and interpretation of the test results are also within the scope of interest. Space propulsion testing, contamination effects and scene sources are of interest. Hypervelocity launchers for reentry and impact testing, along with associated operational and measurement problems are of interest. Many of the methods of simulation now used for these technical areas involve compromise of test conditions, high cost, poor productivity, or other major problems where innovative approaches might provide much needed benefits.

AF91-021 TITLE: Miniaturized, Non-contacting, Docking Device for Wind-Tunnel Models and Probing Devices

OBJECTIVE: Develop a non-contacting mechanism to be used to detect the distance between two bodies.

DESCRIPTION: In a continuous flow hypersonic wind tunnel, the most reliable method for tracking and positioning one test article relative to another or for locating a probe on a model surface usually involves a manual operation using an optical imaging system. Unfortunately, there are many circumstances where this optical technique will not work. A more useful automatic docking or positioning system would be one that was located on the traversing probe or model. Space on the model/probing mechanism is limited and, therefore, the mechanism must be less than 18 inches long with a diameter of nominally 0.1 inches. The detector should have a depth of field of at least 1 inch with an accuracy of +/- 0.002 inches. The device must be able to withstand surface recovery temperatures of 1300 degrees F and pressures from 0.05 to 50 psia. Any electronics or cables to the sensor must be able to survive temperatures up to 1000 degrees F and the vibrational and acoustic environment of a hypersonic wind tunnel. The support hardware to the model/probe is normally water cooled. Phase I should focus on demonstrating the feasibility of such a device and provide a conceptual design. In Phase II a prototype device should be fabricated and tested in a wind tunnel at AEDC.

AF91-022 TITLE: Highly Responsive, Gaseous Hydrogen, Sensor System

OBJECTIVE: Develop a gaseous hydrogen sensor system with a total response time not greater than 0.25 seconds.

DESCRIPTION: A highly responsive gaseous hydrogen sensor is required for operation in process air ducting at AEDC. The gaseous hydrogen detection systems currently available have unacceptable response times of 7 to 300 seconds. The total system response shall be no greater than 0.25 seconds. System response is defined as the end-to-end time for the sensor to detect a hydrogen level between 0.5% and 2.5% by volume and provide a signal. The sensor should work in a pressure range of 0.5 to 15.0 psia and a temperature range of 500 to 3000 degrees R. The sensor will meet all requirements for the National Electric Code Class 1, Division II, Group B Classification. In Phase I a preliminary design must be completed along with a practical demonstration of the device in a simulated ground test environment. Phase II should result in the fabrication and testing of a prototype sensor.

AF91-023 TITLE: Dynamic Stress Analysis for Projectiles

OBJECTIVE: Predict dynamic stresses for projectiles launched at hypervelocities in the ballistic ranges at AEDC.

DESCRIPTION: A computer code is required to perform dynamic stress analysis of projectiles launched at hypervelocities in the ballistic ranges at Arnold Engineering Development Center. The projectiles are constructed of metals, plastics, and composite materials and are subjected to acceleration loads of several hundred thousand times gravitational acceleration (g's). They are also subject to elastic and plastic deformations. The major loading is axial but the effects of side loads must also be included. If necessary the code may be designed for use on a supercomputer as AEDC has a CRAY X-MP-12. The source code will be provided along with documentation on its use. Phase I should focus on proving the feasibility of performing this analysis on simple geometric shapes and should result in a prototype code which can be demonstrated at AEDC on Air Force computers. Phase II should result in a code that will provide all the required output for typical model configurations along with proper documentation.

AF91-024 TITLE: Dynamic Model Tester

OBJECTIVE: Develop a device to test model and sabot designs under equivalent dynamic conditions.

DESCRIPTION: A device is required to test model and sabot designs under representative dynamic conditions prior to launch from a hypervelocity, two-stage, light gas launcher. Model/sabot failure can cause serious damage to the launch tube. The device should apply a step stress wave to the test model equivalent to the peak step stress encountered by the model in an actual launch. The device should also simulate the presence of the launch tube. Magnitude and duration of the stress is to be controlled. Output should include condition of the model/sabot after test and the measured magnitude and duration of the stress pulse. Desirable outputs would be the strains of various portions of the model and sabot. Phase I should focus on a preliminary design and proving the feasibility of the concept. Phase II should result in a prototype device to be tested at AEDC.

AF91-025 TITLE: Command-Control-and-Communications (C3) Systems/Subsystems

OBJECTIVE: Develop innovative concepts for increasing warfighting capabilities of the Air Force (C3) Systems.

DESCRIPTION: Proposals may address all aspects of AF C3 systems/subsystems not specifically given in other SBIR topics. Proposals may cover any of the following AF C3 missions: Strategic C3; Tactical AF C3I; Theater interoperability for joint and combined operations; NATO Air Command and Control Systems; Air Space Management; C3 systems for AF mobility and Special Operations Forces missions; Air, Missile and Space Integrated Tactical Warning/Attack Assessment C3; World wide C2; All AF ground based and airborne early warning systems; All AF communication systems and C3 countermeasures and electronic warfare. This topic offers great flexibility to bidders to propose solutions addressing AF problems. Past submissions included 1) Advanced Communication Systems, 2) Air Space Management Capabilities, 3) Multilevel Communications Security Concepts, 4) Manufacturing Productivity Tools, 5) Air Surveillance Systems, and 6) Relocatable Target Detection System. AF managers evaluate proposals on their merits and applicability to ESD programs.

AF91-026 TITLE: Transportable Very-Low-Frequency (VLF) and Low-Frequency (LF) Transmit Antenna

OBJECTIVE: Develop and demonstrate transportable antennas capable of operation at very low frequencies or at low frequencies.DESCRIPTION: Present Very Low Frequency (VLF) and/or Low Frequency (LF) transmit antennas are either very large ground installations, or very long trailing wires from airborne aircraft. There are no physically small transportable transmitting antennas that are compatible with a ground mobile command and control capability at these frequencies. A capability is necessary to allow transmission of VLF and/or LF message communication from ground mobile platforms either truck or rail-borne. This capability would need to be operable by a small crew and be operational within a few hours from start of set-up. Minimum special conditions for set-up are desirable. The antenna either needs to be recoverable in a similar time or be expendable - with multiple units (reasonable quantity) carried with a command element - and allowing that element to move several times with a VLF and/or LF capability possible at each stop. The proposal must address what would be accomplished during Phase I which would allow the antenna implementation and demonstration to be accomplished in Phase II.

AF91-027 TITLE: Automated, Remote, Chemical and Biological, Sensor-Reporting System

OBJECTIVE: Develop and demonstrate a warning system capable of detecting known chemical and biological agents at remote locations and notifying base level warning systems.

DESCRIPTION: Development of an automatic reporting system for remote groups of sensors for chemical and biological agent detection in the air and air base drinking water supply is required. The system will form part of the air base facilities for recovery after attack and must survive any type threat which could be imposed against an air base in a theater environment. The sensor(s) should detect impingement of known liquid, vapor, aerosol, thickened, and solid (particulate) chemicals. Detection and alarm notification of the chemical/biological agents for an on-target attack should occur within two minutes. Once a sensor detection decision has been made, the automated notification to the air base alarm center should occur within 30 seconds. False alarm rates should not exceed 0.04 per hour. The reporting system must operate without the requirement for personnel to physically inspect the individual detection and warning sensors placed through out the base. The system connectivity between the sensors and the base alarm center must be survivable and capable of remote independent operation. A radio transmission capability between the sensors and the alarm system is preferred, but alternatives may be proposed. The typical air base alarm system with which the reporting system must operate is built around microcomputers using a UNIX operating system, relational data base and X-Windows. The information relayed must provide detection notice, agent type, concentration of the agent, and sensor location. Key system parameters must have high reliability and be easily inspected/maintained/repaired, accurate in all weather conditions, easily decontaminated, and capable of expansion as new chemical/biological agents become known. The proposal must address what would be accomplished during Phase I which would allow demonstration of the reporting system during Phase II.

AF91-028 TITLE: Commercialization of New, Gaseous-Reactor Technology for Vapor Phase Deposition

OBJECTIVE: Implement deposition reactor for production of epilayers on single or multiple wafers using organometallic epitaxy or other vapor growth process.

DESCRIPTION: Vapor phase epitaxy is used to grow multilayer semiconductor structures, including quantum wells and superlattices, for a variety of electronic and optoelectronic applications. New reactor technology provides laterally uniform epilayers over large areas, and abrupt or graded compositional changes between successive layers in a controlled manner. This thin-film technology provides for precise control of layer thickness, composition, and doping for reactors operating in the viscous

flow regime. A vertical, rotating-disk, single-wafer reactor that permits such control has been developed, and its utilization for organometallic vapor phase epitaxy has been demonstrated. Thickness uniformity of 1% and AlGaAs compositional uniformity of 0.1% have been obtained for epilayers grown on 5 cm diameter substrates. Heterostructures have been grown by molecular beam epitaxy. A detailed description of the demonstrated reactor, including machine drawings, will be available to the SBIR awardee. The technology to be provided under this topic is patented and subject to a royalty fee for commercial sales to other than United States government or its contractors. The patent owner will grant an option for the SBIR awardee to negotiate a royalty bearing, limited-term exclusive license to the patent rights. During the option period the SBIR awardee will have the right to use the patent rights for research purposes. Phase I Evaluation will be based on the business plan presented to transition vapor phase deposition reactor technology into a saleable product or wafer production capability and associated marketing plan. Phase II Evaluation will be based on accomplishments during Phase I period and updated business plan.

AF91-029 TITLE: Automated, Battlefield, Radio-Frequency Manager

OBJECTIVE: Provide an automated system to support the management of the radio frequency spectrum of a battlefield environment.

DESCRIPTION: Develop and demonstrate a capability to allowing a radio frequency manager to automatically assign operating frequencies to military units operating within the managers area of responsibility (AOR). The system must respond to changes in the number of operating units or personnel within the manager's AOR. Desired attributes include 1) Automatic processing (with manual input possible) of the communication equipment (receiver, transmitter, antenna) assigned to the military units, within agiven area, that require frequency assignments; 2) Accepting changes in the number of military units or communication equipment assets within a given area; 3) Processing changing unit frequency requirements and operating priorities and proposing alternative redistributed frequency assignments based on current or planned operations; 4) Automatic processing (with manual input possible) of the data on hostile forces operating frequencies, electric warfare assets and current status; 5) Analyzing hostile forces data and proposing frequency assignments for friendly forces and assess the probability of successful communication given the hostile forces capabilities; 6) Graphically depicting the frequency spectrum (by frequency band) showing assigned military units frequencies, hostile frequencies, jammed frequencies, etc. All military frequency bands from 3MHz to 44 GHz may be included, and terrain effects on line of sight frequencies may be included in the spectrum analysis process. The Phase I objective is to develop a functional description and an implementation concept for demonstration of the frequency manager during Phase II.

AF91-030 TITLE: Advanced Technology Application for Small/Manpack, UHF, Satellite Terminals

OBJECTIVE: Design Concept for a new lightweight advanced-technology, UHF, Satellite, manpack terminal with DAMA capabilities for DATA and voice.

DESCRIPTION: UHF Satellite Terminal Technology has progressed to a point where new state-of-the-art devices are/will be available for use in the next generation UHF manpack satellite terminal. Survey and assess those state-of-the-art advances in UHF device technologies. Determine device advancements in RF/IF and monolithic components, microprocessors, SAW and Charge Coupled Device (CCD) processors, digital signal processors, Power Generation Devices, VHSIC components and other technology applications for UHF Satellite Terminal design. During Phase I prepare a functional description/top-level design of a new Advanced UHF Satellite Terminal incorporating the results of the device survey. During Phase II the terminal design will be developed and demonstrated.

AF91-031 TITLE: Computer-aided, Software, Fault-Tolerant-System Development

OBJECTIVE: Develop a set of automated tools to assist in the production of systems which incorporate software fault-tolerance technology to achieve high reliability.

DESCRIPTION: To meet the stringent reliability requirements of many mission critical software systems, the development process for them should include the insertion of software fault-tolerance technology during the earliest possible phases of the software life cycle in order to reduce costs and risks. The opportunity exists to lend automated assistance to the development process through the Software Life-Cycle Support Environment (SLCSE), which is comprised of an extensible set of tools that share a common database. The integration of tools and data structures with the SLCSE will support software fault-tolerance technology and its insertion into the system software development process. In order to effectively accomplish this, it will be necessary to have a better understanding of software fault-tolerance models and techniques, their data inputs and outputs, and the tools that currently exist or need to be developed. It is also advantageous to adhere to standards that directly apply to system and software fault tolerance for enhanced usability, interoperability, and extensibility of the tool set. Phase I of this effort will consist

of three areas of research and development and a technical report documenting the results of each. The first area involves the investigation, development, and enhancement of software fault-tolerance models/techniques, and the definition of their data inputs and outputs. The second area involves the investigation of the market place for automated tools that produce data for or use data from such models and techniques. The investigation should also determine the feasibility of (1) integrating existing tools with the SLCSE and (2) developing new SLCSE tools to fill the gaps in the market place. The third area involves the investigation of existing and emerging standards related to software fault tolerance and to the application of this knowledge to both Phase I and Phase II activities. Phase II of this effort will include the development of a prototype tool set that consists of at least one automated, software, fault-tolerant-system-development tool that demonstrates its utilization of SLCSE project database information to enable the insertion of software fault-tolerance technology into the earlier phases of the system software-development life-cycle, and the resulting payoff in terms of improved system reliability. The work expected to be performed during Phase III of this effort is the enhancement of the initial tool set developed during Phase II.

AF91-032 TITLE: Application of Natural Language Technology to Advanced Software Engineering Environments

OBJECTIVE: Investigate the potential application of state-of-the-art text-generation technology within advanced software engineering environments.

DESCRIPTION: Advanced software engineering environments consist of numerous software development tools and support a variety of software development methodologies and personnel. One area of significant concern within these varying environments is that of user interface, i.e., displaying information to the user in an easy to understand format. Current software test tools,for example, generate detailed tables that indicate, module by module, the outcome of each test. Many times a high level manager desires a more textual report that provides the overall status of testing activities. In addition, there are numerous applications possible in the area of support for project management. A natural-language text-generation system, in conjunction with project-management and database software, can significantly broaden the usability and applicability of project management reports. Complex tables, figures, and charts can be reduced to meaningful text and keyed to the appropriate level of management. The technical challenges of this effort are to develop the technology to provide this text in a meaningful way: 1) the text is automatically derived from the project development activities; 2) it does not become repetitive or awkward; and 3) the manager can immediately obtain the reasons why certain conclusions were made about the status of the project. Phase I will investigate the feasibility of the application of state-of-the-art text-generation technology within an advanced software engineering environment, addressing high payoff areas of application and highlighting the area of project management. An initial application of this technology to the problem of project-management reporting will investigate the following: a) automatically generating text, tables, figures, and graphs, which provide an analysis of project spending, percent completion, expenditure rate, milestones met available resources; b) providing an analysis in terms of the current project status as well as the status over a period of time; and c) entity-relationship and object-base data models. The results of Phase I will be documented in a Final Technical Report. Phase II will develop and deliver a prototype natural-language-text generation system for one of the application areas identified during Phase I.

AF91-033 TITLE: High-Modulation-Rate Optical Detectors

OBJECTIVE: Develop an integrated optical detector for microwave-modulated optical signals.

DESCRIPTION: Transmission of microwave signals via optical carriers has been demonstrated. Replacement of microwave/millimetric waveguide with photonic waveguide (e.g. fiber optics, SiN, AlGaAs/GaAs) will have a profound impact on military systems heavily dependent upon microwave hardware: antenna manifolds, interconnections, phased array antennas. Replacement with photonic waveguide demands transparent operation; that is, what was a passive microwave waveguide has been replaced by an active photonic system. High modulation rate laser sources and external modulators have been demonstrated at microwave/millimetric wave frequencies. High-speed detectors have also been demonstrated, but they are low dynamic range and efficiency. What is needed is an integrated optical detector that provides microwave/millimetric gain. Optical wavelength of choice is 1.3 um to minimize photonic waveguide loss. Radio frequencies of interest are at 2-4 GHz, 8-10 GHz, 20 GHz (nominal +/- ten percent), and 44 GHz (nominal +/- ten percent). Traveling wave versus area detectors may offer the greatest advantage in linearity and dynamic range. In Phase I, study and limited experimentation will be accomplished. In Phase II, demonstration breadboard will be fabricated.

AF91-034 TITLE: Efficient Network Models

OBJECTIVE: Develop efficient, user-oriented, network-level, communications performance models suitable for DoD.

DESCRIPTION: Data communications and networking are technology bottlenecks in military weapons systems. The problem is assured/secure communications for users. Military communications must be user friendly yet responsive to command requirements. Simulation and modeling is the critical defense technology used for performance analysis of communication network alternatives. The technical challenge is to construct a tool that gives insight into the difficulties of resource allocation in communications network design to satisfy user requirements for data communications service. Importance sampling, knowledge engineering etc. have not yet yielded a suitable tool. In communications, the cost of providing service exceeding requirements must be traded off against the time value function to the end user. Phase I of this effort would develop methods for modelling efficient experiments to evaluate network performance. Experiments have become huge with embarrassingly large amounts of data with little useful information content. Phase II will propose development of an accurate and complete model for DoD communications networks that is capable of quick simulation while providing coarse but accurate results.

AF91-035 TITLE: Active, Programmable, Microwave, Directional Coupler

OBJECTIVE: Design, build and test a programmable active microwave directional coupler which would be suitable for inclusion into the transmit/receive module of an airborne, phased-array, antenna system used as surveillance radar.

DESCRIPTION: Current beamforming techniques for active aperture powered radar systems require the production of directional couplers with coupling coefficients that are a function of the element position. The challenge of this effort is the development of a programmable directional coupler that will be affordable due to the capabilities of Gallium Arsenide technology. The coupling ratio will be programmed as a function of scan angle by the use of microprocessors residing at the element level. Moving the coupler into the T/R module which powers each element would then result in mechanically simpler microwave systems with increased reliability. The directional coupler should pass, with unity gain, no loss, and phase dispersion correctable to 2.5 degrees root mean square (RMS) phase error, an exciter signal that provides the transmit pulse for the radar. The coupler should be capable of splitting the received signal along two paths. One path would correspond to the transmit path previously mentioned, and the other path would be operated over a 30 dB range with the same phase requirements as on transmit. Switching speed is to be consistent with a radar antenna operating in a wide-angle surveillance mode. Frequency response of the device should support 10% - 20% instantaneous bandwidth in any microwave band. In Phase I of this effort a detailed design tothe component level of such a device is requested. In Phase II of this effort the device is to be fabricated and tested. The ability of this device to support ultra-low, sidelobe, phased-array (1) antennas is to be demonstrated.

AF91-036 TITLE: Remote-Antenna Fiber-Optic Link

OBJECTIVE: Develop Remote-Powered, Fiber-Optic, Cable System for Operation at Millimeter Wave Frequencies.

DESCRIPTION: Fiber-optic cables are an attractive replacement for coaxial cables where electromagnetic isolation of the antenna from the receiver is desired. Coaxial cable constitutes unacceptable bulk and weight to the application at millimeter wave frequencies. Presently, most applications require a power source at the antenna termination as well as the receiver. Limited research and development has resulted in small probe-like antennas which use light through a fiber-optic cable to supply biasing current for a semiconductor laser. Systems have been developed with excellent bandwidth and dynamic range properties to about 10GHz using a few meters of fiber. Phase I will investigate techniques to overcome frequency limitations of the laser diode modulator. Phase I will also investigate techniques to increase the minimum distance through a fiber-optic cable that a laser may be remotely powered. Phase II will implement the most feasible approach that was investigated during Phase I. A design goal minimum will be a device capable of operation from 1-100 GhZ. The fiber-optic cable length will be a minimum of 40 meters. The Phase II effort will also include fabrication and demonstrations of the prototype device.

AF91-037 TITLE: Novel, Perovskite, Crystal Substrate for Thin-Film Supercondutors

OBJECTIVE: Determine a compound suitable for thin-film growth of superconducting YBaCuO (1,2,3) which is thermodynamically stable from 77K to 1000K, and develop a method for synthesis and growth.

DESCRIPTION: High-temperature, superconducting thin films can be grown on some perovskite compounds because they are nearly lattice matched to the YBaCuO (1,2,3) crystal structure. Research on thin-film superconductors has advanced to the point where small areas can be produced with acceptable properties and high critical temperatures. However, one obstacle to production of large areas of uniform quality is the substrate material itself. The available substrate materials either have high dielectric constants or exhibit crystal transformations during processing which cause surface roughening of the thin film. A compound must be found which will not twin or transform between 77K and 1000K, and its crystal structure must have a low dielectric constant (near 10). The Phase I objective is to synthesize a compound which can meet the requirements and determine

its thermodynamic stability by x-ray analysis. Phase II will demonstrate growth of single crystals which will be tested for use as substrates for high temperature superconducting films.

AF91-038 TITLE: Ternary, Spatial-Light Modulators

OBJECTIVE: Develop three- and four-state, electrically addressed, phase-dominant, spatial-light modulators.

DESCRIPTION: Electrically addressed spatial light modulators (SLMs) are key components in optical correlation systems for applications in automatic target recognition and robotic vision. Phase-only and phase dominant SLMs have been identified as optimal approaches to smart filtering. Recent experimental work with binary phase-only filters, although promising, has revealed the need for another generation of SLMs that are more sophisticated. Specifically, three-state (ternary) and four-state (quaternary) phase dominant SLMs are required for improved correlation performance. In such devices, the phase state of a pixel is denoted by F1 and the corresponding amplitude output by A1. The ternary SLM in this project is required to have the states F1, F2, F3 = x, 0.5 pi, 1.5 pi with A1, A2, and A3 = 0, 1, 1, respectively; where x is arbitrary and the unity output amplitudes have the same optical polarization. For the quaternary SLM, the goals are F1, F2, F3, F4 = x, 0.5 pi, pi, 1.5 pi with A1, A2, A3, A4 = 1v, 1h, 2v, 1h, respectively; where v and h represent vertically or horizontally polarized output light. The use of ferroelectric liquid crystals or other electro-optic materials is an acceptable approach. The reconfiguration time of each pixel should be less than 100 microseconds. It is acceptable to fabricate each pixel as a composite of two optical elements in series. The contractor will provide resolution of the SLM, taking depths and area into consideration. Phase I will consist of the fabrication of a small array in order to prove the principle. Phase II will consist of implementation in a large working array.

AF91-039 TITLE: Development and Construction of a New Vapor Phase Epitaxy (VPE) Reactor for the Production of Multiple Quantum Well Structures

OBJECTIVE: Develop a new reactor to produce the next generation of photonics devices.

DESCRIPTION: The next generation of commercial photonic devices will be primarily based on multiple quantum-well structures. The structures will be either thin films of superlattices or strained layer superlattices of the III-V semiconductors. Current methods for production of layered structures are molecular beam epitaxy (MBE), metal organic chemical vapor epitaxy (MOCVD), and has problems with carbon incorporation; MBE is expensive and production yields are low. VPE has beenconsistently capable of producing high quality III-V semiconductors. The study requires an understanding of the controlled fabrication of semiconductor thin films with high crystal perfection using the various epitaxy techniques. The VPE technology may be based on either the chloride or hydride system. The new reactor should incorporate the advantages exhibited by MOCVD and MBE with those of conventional VPE. The reactor should have the capability of in-situ monitoring of the growing layers. This technology will also be valuable for the production of high frequency electronic devices. Phase I of this program will deal with reactor design and address solutions to current limitations in VPE technology. Phase II will construct the reactor and demonstrate its improved capabilities.

AF91-040 TITLE: Scanning Tunnelling Microscopy for Advanced Device Processing

OBJECTIVE: Develop scanning tunneling microscopy (STM) for ultra fine structure device processing.

DESCRIPTION: The scanning tunnelling microscope recently has been shown to be an excellent tool for lithography to 0.1 micron dimensions. This region is currently inaccessible to optical and E-beam lithographic techniques. The STM, on the other hand, is capable of atomic level resolution and is surprisingly easy to operate in the nanometer resolution region. This reduced scale opens up a new area of device physics. Entirely new families of quantum devices can potentially be processed onto existing chips with this technique. The Phase I objective is to define the operational criteria that will allow the STM to become an effective add on attachment to current device processing equipment. The Phase II objective is to fabricate the STM attachment that will be retrofitted into existing process equipment. The device will be qualified by the production of quantum lines on the surface of a silicon based device.

AF91-041 TITLE: Microwave-Processed Sol-Gel Glasses and Ceramics

OBJECTIVE: Develop techniques and apparatus for processing glasses and ceramics prepared by sol gel and other techniques, necessary for nonlinear optics and high temperature superconductor applications, using new microwave technique.

DESCRIPTION: A wide variety of techniques have been employed for drying, sintering and annealing of sol-gel prepared films and monolith. Among the serious problems that face the progress of sol gel technology are: incorporation of crucial active elements in the solution and maintenance of stoichiometry during drying, and fracture of films and monolith. For example, in the nonlinear optics (NLO) it is necessary to use sol gel technique to prepare very high silica glass films and bulk pieces containing active elements (e.g. Pb, Ga, Bi, Nd, etc). Incorporating such elements and maintaining the stoichiometry during the process is very difficult. Similar problems are faced in high-temperature superconductor (HTS) films prepared by the advantageous sol-gel technique. Regardless of the applications, heat treatment is necessary to achieve dry, dense, and completely sintered films and bulk pieces that have the correct stoichiometry, microstructure homogeneity, the correct density, high strength and most of all improved NLO and HTS parameters. To date, conventional furnaces are the only means by which heat treatment can be accomplished. Due to the radiant nature of heating with these furnaces, the heating rates are generally slow. Because the material is heated from its exterior, temperature gradients exist within the material during processing. Microwave processing of materials is an emerging and exciting technique. In this novel processing approach, heat is generated within the material by the dissipation of microwave energy. This internal heating mechanism enhances the processing rates, resulting in more homogeneous materials with finer and more uniform structure, thus improving the properties and reliability of glasses and ceramics. In microwave-dried, -sintered, and -annealed NLO and HTS, the combination of higher heating rates, controlled thermal gradients and higher diffusion of oxygen should result in more uniform microstructure and better properties. In Phase I, feasibility of the microwave technique and improvement of properties over conventional processing techniques should be demonstrated. A microwave processing apparatus suitable for laboratory research in ceramics and glasses is to be designed. In Phase II the apparatus must be constructed and tested. CuO-based superconductors will be optimized. Other ceramic compositions, e.g., Bi2O3-based will also be tried. Deliverables will include the apparatus.

AF91-042 TITLE: Volume Holographic Recording Glasses

OBJECTIVE: Develop improved Bragg filters using disordered solids.

DESCRIPTION: It has recently been shown that amorphous solids can be utilized as volume holographic recording media using selected write-beam wavelengths. An approach to accomplish this is to locally induce shifts in the color-centers of the material through an optically sensitive structural modification and/or an electronic transfer mechanism which effects a change in the refracting properties of the medium through the Kramers-Kronig relationship. Some examples of this development can be found in rare earth-doped phosphate and silicate glasses, and in GeO(2)-doped silicate glass which has an ultraviolet absorption band that can be bleached using excimer laser beams. Since glass can be molded into various geometries, drawn into fiber, and manufactured cheaply, photorefractive glass systems could be quite useful to the design and fabrication of Bragg filters, couplers, optical frequency demultiplexers, and read/write/erase optical memories. Furthermore, research to date has shown that amorphous materials have the ability to record gratings which are in phase with the interfering write beams. This provides a substantialimprovement over single crystal photorefractive materials by eliminating phase noise in optical signal processing systems. Widespr^ad application of the rare earth-doped glass systems is currently limited by the low scattering efficiencies of the induced refractive index gratings to optical wavelengths of practical interests in the near-infrared; the GeO2-doped glasses cannot have their photosensitivity tuned to accommodate holographic encryption using other laser systems. This program should address an approach to advance the current state of the art by developing stable glass systems in which transient and permanent/erasable refractive icx gratings can be recorded using visible or diode laser optical sources and have enhanced scattering efficiencies to signals in the near-infrared optical spectrum, i.e., approaching or exceeding 0.1. In Phase I glasses should be prepared which demonstrate feasibility of the approach. Phase II should focus on optimizing scattering efficiencies in these materials and their complete characterization, as well as the preparation and demonstration of specific filter geometries and component fabrication.

AF91-043 TITLE: High-Speed Optical Image Processors in Rare Doped Glasses

OBJECTIVE: Develop an optical processor to modulate 0.8 and 1.315 micron pulsed images at nanosecond or picosecond gate intervals.

DESCRIPTION: Stimulated photon echoes from optically active ions in glasses have been used to study effects related to the molecular dynamics of the host medium in the immediate vicinity of the active site. Recently, photon echoes have been suggested for use in high-speed optical circuitry and in memory-storage-device applications. Since active ions can generally be incorporated into the matrix of a glass in higher concentrations than they can be doped into the lattice of a crystal, amorphous solids have the potential to be a more suitable host material for these applications. Phase I of this program should determine the more suitable host glass compositions on the basis of the system, potential, dynamic range and its resistance to thermal distortion under various optical fluences. It should also identify candidate rare earth ions and compensate for the effect of cross-relaxation mechanisms on echo signal intensity as it relates to rare earth-doping levels. Phase II of the program should focus on the practical testing and

refinement of photon-echo-optic image processing circuits, such as pattern recognition, correlator, spatial masking and logic circuits, operating at 0.8 and 1.315 micron wavelengths from the preferred materials.

AF91-044 TITLE: Memory Media for Three-Dimensional, Photonic, Memory Architectures

OBJECTIVE: Investigate and develop media for use in 3-D optical memory architectures.

DESCRIPTION: Soon electronic computers will be handling computational rates exceeding one trillion FLOPs. Perhaps the greatest deficiency in the development of these machines is in the area of memory. At this time, electronic memory devices are not capable of delivering the data rates necessary for the computers of the future. Three-dimensional optical-memory technology has been theoretically identified as one area where the strengths of photonics can overcome this bottleneck. Materials research is badly needed to find and develop materials useful for three-dimensional memory devices. Phase I will develop potential memory media that could offer orders-of-magnitude improvement over existing memory media. Phase II will implement chosen storage material into a demonstrable system.

AF91-045 TITLE: Free-Space Optical Interconnects

OBJECTIVE: Study the problem of design and fabrication of free space optical interconnects for future computer interconnect applications.

DESCRIPTION: Possible optical memory architectures of the future necessitate the development of high-bandwidth, optical, interconnect devices. Due to the necessity for high data rates, and memory requirements for computers in the future, optical 3-D memory technology has been identified as one possible solution to this problem. Some architectures for 3-D memory show great promise for on-line memory needs of the future. One problem with the implementation of such devices is in the area of device interconnections. At this time, no electronic or fiber-optic bus meets the needs of these devices. Free-space interconnects have great potential to correct this deficiency. The relative ease of maintenance and extremely high data rates make these interconnects attractive. The greatest difficulty is in the implementation of these devices at this time due to their vibrational sensitivity. For this reason, amplitude-independent digital-encoding techniques should be studied. During Phase I contractor will demonstrate, via Engineering Development Model, a one-channel, free-space, optical interconnect to maximize efficiency, amplitude modulation tolerance, environmental isolation and digital throughput. Phase II will demonstrate, as a minimum, a 16 or 32 bit standard input/output optical interconnect system for a microcomputer.

AF91-046 TITLE: Semiconductor Optical Amplifier Interconnects

OBJECTIVE: Develop improved approaches for amplified optical interconnects utilizing semiconductor direct optical amplifiers.

DESCRIPTION: Future designs of Air Force digital signal processors will employ optical interconnects utilizing photonics technology, a DoD Critical Technology. Current interconnect components have large inherent attenuation. The successful implementation of digital signal-processing architectures depends on overcoming this limitation. While many semiconductor optical amplifiers have an internal gain of 30dB, the gain available after interfacing is typically only 7dB. This represents a serious loss in performance. In Phase I develop innovative methods for interfacing semiconductor optical amplifiers into OEIC or fiber-optical circuits. Procure or fabricate amplifiers as part of this effort and process and test the concept in a collaborative effort working in the RADC Photonics Laboratory and the Cornell National Nanofabrication Facility. In Phase II, working in the Photonics Laboratory, develop the Phase I concepts to optimize performance and provide a working, subsystem, interconnect demonstration.

AF91-047 TITLE: 3D Micromovement Analysis Facility

OBJECTIVE: Demonstrate a facility capable of experimentally verifying the thermal and vibrational finite element analysis (FEA) of microcircuit packaging.

DESCRIPTION: While significant effort has been consumed in developing FEA tools for modelling and predicting the reliability of new microcircuit package designs, interconnection methods, and technologies, there has been no demonstration of a capability for experimentally verifying the validity of the models, methods, and assumptions used. This requirement is for the demonstration, verification and utilization of a facility capable of measuring the actual thermal expansion and/or vibrational micromovements of microcircuits and their assemblies in a manner that will allow the correlation and verification of FEA models. Phase I will require the development and demonstration of a suitable experimental method to verify the validity of the models, methods, and assumptions used. Phase II will require the verification of a group of FEA models.

AF91-048 TITLE: Hypertext-Based Reliability and Maintainability Advisor for Computer-Aided Design

OBJECTIVE: Develop a hypertext system to advise electronic system designers on reliability and maintainability design aspects.

DESCRIPTION: There is currently a lack of efficient means for providing electronic circuit and systems designers information relevant to the reliability and maintainability aspects of their design in a manner that is both user-driven and minimally interruptive to the design process. A software tool is needed to interface a reliability and maintainability (R&M) knowledge base to a computer-aided design (CAD) workstation environment. This should be accomplished in such a way that the user can transition back and forth between the contexts of R&M and design with minimal difficulty. The user would have total control of the sequence in which they accessed the R&M knowledge base, entering and leaving it at times, locations and contexts of their own choosing without losing their place in the CAD design process. The interface between the CAD software and the R&M knowledge base should be based on an emerging class of man-machine interfaces and database management techniques collectively known as hypertext. Phase I would involve the development of a representative R&M knowledge base and its hypertext interface along with an approach for integrating this software into existing CAD hardware/software environments. Phase II would expand the knowledge base and develop a prototype implementation of the integrated hypertext and CAD environments.

AF91-049 TITLE: Automated Thermal and Vibration Assessment of Electronic Devices Using Closed Form Procedures

OBJECTIVE: Provide an automated, computer-based, thermal, shock, and vibration-assessment capability for electronic devices.

DESCRIPTION: The finite element analysis approach to predict the response of devices and structures to thermal and dynamic environments is technically sound and valid; however, the approach is also time-consuming, computer-intensive, and requires skilled engineering resources. A reliability assessment capability is needed that would allow a rapid assessment of electronic devices subjected to a defined thermal, shock, or vibration environment in order to isolate problem areas which may require detailed, finite, element analyses. Closed-form procedures using strength of materials' relationships, empirical data, or other simplified analytical techniques would be used, with input data provided in a question/answer format to automatically determine device response. Phase I of this effort will determine the approach needed to accomplish the objective and will also develop a proof-of-concept code to demonstrate feasibility and to verify results. Both thermal and dynamic loads will be considered. Phase II will develop the complete code and contain a data base for a wide variety of electronic devices, interconnects, and subsystems.

AF91-050 TITLE: Photonics Transducers

OBJECTIVE: Develop low-insertion-loss, high-frequency, photonic transducers.

DESCRIPTION: Most forward-looking avionic-system designs include high levels of integration among the various avionic subsystems resident on the projected platform. These levels of integration imply extremely high bandwidths for both analog and digital signal types. Fiber-optic (or photonic) interfaces are expected to play a crucial role in the required digital interfaces, but the extremely high insertion loss of available photonic transducers to high- frequency signals (>1 GHz) greatly limits theirapplicability to many high frequency functions. Specifically, a variety of radio frequency (RF) and high-frequency IF manifolding and beamsteering functions could be greatly simplified using photonic transmission or combination of signals if sufficiently low-loss photonic transducers were available. The co-integration of GaAs transducers with primary RF MMIC chips is also possible and would represent a significant reduction in size and a substantial increase in reliability. Thus the proposed Phase I investigates techniques for low-loss fiber-optic transduction. During Phase II a detailed design, fabrication, and test of the most promising concepts will be accomplished. Following proof-of-concept demonstration by the small business investigator, a joint effort may be possible between that investigator and a major MMIC design house/foundry where an investigation of possible monolithic implementations would integrate the low-loss transducer and primary RF circuitry within the same MMIC chip so that RF amplifier/manifold/true-time-delay hybrids could be implemented comprising two or three IC's associated power distribution and photonic interconnections. These in turn, could form the building blocks for next-generation shared-aperture systems.

AF91-051 TITLE: Update Method for Inertial Navigation System

OBJECTIVE: Develop a method for updating the on-board inertial navigation system in order to provide position accuracy to within +/-1 foot of absolute position relative to earth's surface.

DESCRIPTION: In order for a mobile rapid runway repair (RRR) robot to be able to navigate to the edge of a bomb crater on a damaged airfield, the absolute position of the robot will have to be known to within +/-1 foot. Current update systems such as the Global Positioning System (GPS) and Loran are accurate to within +/-3 feet, under the best of conditions. Reliable updates

to inertial navigation system and/or correlation with digitized maps of air base features are seen as critical for air base response to damaged runways. These updates would be necessary for reliable, consistent repair of damage without exposure of human resources to hazardous environments. Phase I will determine feasibility of objective stated above.
Phase II will develop the capability of a one-foot absolute position error.

AF91-052 TITLE: Sensor Technology for Rolling Deflection Measurement to Assess the Repair Quality of Bomb-Damaged Runways

OBJECTIVE: Develop sensors, sensor mounting equipment, prototype loading system, and data acquisition system for a rolling deflectometer (load-deflection) test to assess the repair quality of bomb-damaged runways.

DESCRIPTION: Currently, Air Force pavements are evaluated with a Falling Weight Deflectometer. This device tests a relatively small discrete area, which is not adequate for the assessment of repair quality criteria. A continuous (rolling) device is needed which will apply a prototype load to the repaired runway section. Several types of rolling deflectometers (such as the Cox Deflection Device) have been researched, but none of these included sensor systems which would continuously measure a reference elevation (datum) to allow measurement of the changes in the actual deflection basin under the moving load (these devices actually measured curvature, rather than magnitude of deflection). A sensor system is required which will combine with a prototype loading system (similar loading to a heavily loaded aircraft wheel load) to allow measurement of 1) continuous elevations along a line on the repaired runway prior to the load rolling over; 2) continuous deflections at a series of radial points beginning at the load center; and 3) continuous final elevations to measure permanent deflection of the repaired runway surface The system would include sensors, mounting hardware, prototype loading system, and data acquisition equipment needed to complete the required repair quality testing. Phase I will determine feasibility of a rolling (continuous) deflection and measuring device. Phase II will develop and evaluate chosen concepts for field use.

AF91-053 TITLE: Quantity-Distance Criteria for Earth-Bermed Aircraft Shelters

OBJECTIVE: Develop explosive safety (quantity-distance) criteria for an earth-bermed aircraft shelter.

DESCRIPTION: When munitions are stored in a structure, a large strictly zoned area around that structure exists as dictated by safety. The driving criteria for the size of this area is the quantity/distance (Q/D) ratio. Q/D criteria provide a relationship between an explosive weight and a distance to a relative degree of safety should a detonation of the explosive occur. It has been proposed that earth berms placed around concrete aircraft shelters would reduce the Q/D ratio; however, the level of improvement has not been quantified for an internal explosion in an aircraft shelter. This program seeks to develop guidance for determining the change in Q/D distances for earth berming of aircraft shelters, and possibly other explosive storage structures. Phase I will could be determine these effects by engineering analysis, computer modeling, model testing, or any other appropriate technical approach. Phase II will provide conceptual designs and be validated by field testing to determine the effects to existing aircraft shelters, Q/D criteria due to berming and recommended Q/D criteria for earth-bermed aircraft shelters.

AF91-054 TITLE: Iron Control for Air-Stripping Groundwater

OBJECTIVE: Develop a method to control the iron in groundwater so that it does not precipitate out and plug up a packed air-stripping tower during remediation operations.

DESCRIPTION: The Air Force has a need for a technique to control the iron that is present in groundwater pumped through air-stripping columns. Currently iron concentrations of 1-10 milligrams per liter (mg/L) are being oxidized in air-stripping operations. The resulting ferric oxide precipitate grows on the packing material until it restricts the flow of air and water. Similar problems are anticipated in aboveground bioreactors. The technique developed in Phase I can be some type of pretreatment to remove the iron or it can be an additive to alter the iron so that it flows through the column and does not form the precipitate. Phase II, if approved, will be the testing of the technique at flow rates of 30-50 gallons per minute at an Air Force approved site.

AF91-055 TITLE: Advanced, Landfill, Cover Materials

OBJECTIVE: Develop a technologically advanced, waterproof, durable, elastic, cost-effective, self-sealing system for eliminating surface infiltration into landfills and resultant leachate generation.

DESCRIPTION: Older landfill caps consist of local soil and permit precipitation to percolate and contaminate groundwater. Newer caps, especially on hazardous waste sites, consist of various layers of soil, gravel, sand, clay, and stones. Often polyethylene

sheets, geotextiles, and bentonite are sandwiched between these. It is generally accepted that all landfill caps leak due to settling, failure of seals in plastic sheets, biointrusion, pressure of rising methane, or unforeseen traffic. Existing cap designs are also very expensive to install. A technologically advanced, self-sealing blanket is needed to prevent leaks and to pinpoint cap failures for spot repairs. Phase I effort should demonstrate properties of the advanced material in the laboratory, especially leak resistance after being strained. The ability to locate mechanical failures, to wick precipitations sideways or into the atmosphere, and to cope with gas evolution, biointrusion and unwanted traffic are other important properties. Phase II, if approved, would pilot test blanketing materials under simulated field conditions.

AF91-056 TITLE: Methods for Separating and Concentrating Organic Solvents from Groundwater

OBJECTIVE: Develop an innovative technology to separate and concentrate organic solvents such as trichloroethylene contaminated groundwater.

DESCRIPTION: Trichloroethylene (TCE) is the second most common groundwater contaminant organic chemical found at Air Force bases. It is found in a wide range of concentrations, from a minimum of 0.004 g/L up to its solubility limit in water. Treatment of groundwater containing very low levels of TCE is inefficient. Bioreactor and chemical oxidation technologies, under development at AFESC for destroying organic solvent contamination in groundwater, operate more efficiently at higher concentrations (>10ppm) than are typically found at contaminated sites (<100ppb). Therefore, the Air Force has a need for a technology that will concentrate organic solvents from groundwater. This technology should remove 99+ percent of the contaminants from the groundwater stream and concentrate them in a separate water phase. This system must be capable of treating a wide range of TCE concentrations in groundwater (10ppb-100ppb). The system also must resist the effects of inorganic constituents such as iron and calcium that may foul the system. During Phase II, the contractor will develop a system to remove and concentrate TCE from contaminated groundwater. The fouling effects of inorganic constituents in the groundwater will also be examined. During Phase II, if approved, the contractor will scale up the concept and fully characterize its performance capabilities by field testing at a groundwater contamination site.

AF91-057 TITLE: Disposal of Chlorofluorocarbons and Halons

OBJECTIVE: Develop nonpolluting technology to convert CFCs and halons into environmentally benign materials.

DESCRIPTION: CFCs and halons are cited as stratospheric ozone depleters, and, therefore, will be removed from service as refrigerants, firefighting agents, solvents, propellants, and constituents of blown foams. Incineration of these materials is expected to be an unsatisfactory method of disposal, as unburned feeds, products of incomplete combustion, and hydrogen halides produced by complete combustion would require stack treatment prior to release. A technology is needed to convert these materials into an environmentally benign form that can be disposed of as a nonhazardous waste (terminating Resource Conservation and Recovery Act custody) or that can be used for another purpose. Phase I should include experimental demonstration of feasibility of the proposed technology. Phase II should include experimental demonstration of the proposed technology on a kilogram or larger scale, including emission control methods and final disposal of all unusable residues.

AF91-058 TITLE: Liquid Phase Reduction of Chlorinated and Nonchlorinated Organics

OBJECTIVE: Develop a liquid phase treatment system to mineralize dilute concentrations of chlorinated and nonchlorinated organics in groundwater pumped from contaminated aquifers.

DESCRIPTION: Currently, the most common technologies for removing organics from groundwater are activated carbon adsorption and countercurrent air stripping. However, they merely transfer the contaminant to another phase which has to be subsequently treated. The Air Force has a need for a novel treatment system to mineralize the organics while they are still in the aqueous phase. The system would have to remove trichloroethylene (TCE) and benzene down to 4 parts per billion (ppb) from a starting concentration of 50 parts per million (ppm). Phase I is the development and proof of concept of operation of a laboratory scale system capable of proving complete mineralization of the organics and providing scale up and operating parameters for a Phase II effort. Phase II, if approved, will be the operation of the treatment system on contaminated groundwater at an Air Force selected site at a rate of 30-50 gallons per minute.

AF91-059 TITLE: Human Systems/Subsystems Research

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance man's capability to function effectively and safely as an integral part of Air Force systems and military operations while increasing mission success. This includes: 1) human factors engineering, such as methods improving man/machine interfaces or enhancing human physical or cognitive performance; 2) personnel protection/life support, such as crew escape from a transatmospheric vehicle; 3) chemical warfare defense, such as advanced personal and collective protection equipment; 4) occupational/ environmental hazards, such as identification of and protection from toxic materials and electromagnetic or ionizing radiations; and 5) personnel training and simulation, such as new technologies that improve the effectiveness or efficiency of training programs and methods. Ideas are solicited that effect any or all of the operations, maintenance, and support roles of Air Force personnel.

AF91-060 TITLE: Optimal Handling of Medical, Incinerator, Paint Operations and Other Wastes

OBJECTIVE: Minimize medical waste disposal costs; develop technology for reducing incinerator toxics and treating paint waterfalls.

DESCRIPTION: Specific areas include: (Specify subtopic by letter)

a. Minimize medical waste disposal costs. PHASE I: Determine whether factors contributing to medical waste disposal costs can be readily incorporated into an optimization process. PHASE II: Produce an optimization algorithm using factors like number of patient beds, waste volume, type of medical support provided, e.g., nuclear medicine, contractor costs versus on-site treatment costs, fees for air pollution, life-cycle equipment costs, etc.

b. Develop a control technology to reduce toxic hydrocarbon emissions including dioxins, furans, polyaromatic hydrocarbons, etc., frequently associated with medical and municipal waste incinerators. PHASE I: Determine whether technology exists and could be applied to field medical and municipal waste incinerators for the reduction of toxic hydrocarbons. PHASE II: Produce a prototype capable of reducing volatile organic compound's emissions by 75%. These products include chlorinated plastics, pathological waste, and other products of incomplete combustion and polymerization commonly found in emissions from medical and municipal waste incinerators. Describe its design and operation specifications in a supporting technical document.

c. Develop a control technology to reduce soluble and nonsoluble hazardous products from water used in waterfall stripping of airborne compounds in painting operations. PHASE I: Examine the feasibility of developing a small- scale, on-site treatment process for eliminating the hazardous waste component(s) of water used in paint operations. PHASE II: Produce a prototype which will reduce both the soluble and non-soluble components from water used in paint operations. It will be capable of removing solvents, metals, particulates, and other compounds or elements whose presence in the water causes it to be classified as hazardous waste. The resulting water should be dischargeable into the sanitary sewer system. Describe the design and operation specifications of the prototype(s) in a supporting technical document.

AF91-061 TITLE: Application of Artificial Intelligence Technologies to Training Systems

OBJECTIVE: Apply Artificial Intelligence Technologies to Training Systems.

DESCRIPTION: Artificial intelligence technologies hold significant promise for developing automated Intelligent Tutoring Systems (ITS) that achieve a student-to-teacher ratio of one-to-one by customizing presentation of instruction to an individual student. All proposed software systems should run on IBM/XT compatible microcomputer under MS/DOS. Within this topic we invite proposals which address one of the following areas: (Proposals should include the specific subtopic letter as shown below.)

a. Knowledge representation can run the gamut from formal logic grammars (most rigorous) to freedom text (least rigorous). Much research suggests that an optimal approach to knowledge representation in an ITS may be "semiformal" in nature. Examples of semiformal approaches to knowledge representation include hypermedia and frame languages. We wish to examine the semiformal approach to knowledge representation. Proposals in this area, therefore, should cover the specification, design, and implementation of a proof-of-concept ITS in an Air Force domain which uses just such a semiformal approach to knowledge representation. All media, including interactive videodisk (IVD), should be considered.

b. In order for ITSs to adapt to the instructional needs of individual students, they must be able to diagnose skills and knowledge a student possesses at various stages of training. On-line diagnosis of problem solving abilities is a viable near-term goal. Research on student models and Psychometric Theory feed the design and development of a prototype computer based diagnostic testing system. A successful project in this area must 1) design specifications for student modeling; 2) identify psychometric issues and solutions in Computer Based Diagnostic Testing (CBDT); and 3) design, develop, and document a

prototype CBDT Software Shell.

c. Artificial Neural Networks (ANNs) may provide significant capabilities for ITSs in areas such as student modeling, recognition of patterns of "paths" students take through instruction, intelligent interfaces, rule generators for expert systems, and others. Proposals in this area should emphasize a novel application of ANN technology to ITSs.

AF91-062 TITLE: Technology for Manpower, Personnel, Training, and Safety (MPTS) Tradeoff Decisions

OBJECTIVE: Develop a computer-assisted workstation for simulating the impact of MPTS tradeoff decisions.

DESCRIPTION: Weapons development contractors are now required to analyze the logistics, human factors, and MPTS implications of alternative approaches as part of the weapon systems design process. Unfortunately, the available knowledge about MPTS tradeoffs is not well organized or readily accessible; most weapons systems designers do not have all the expertise needed; and most of the needed information on variable relationships is not available in a form that makes it readily available for design purposes. Although computer assisted design (CAD) techniques already permit the study of interactions among large numbers of complex variables the CAD systems, data bases, and expert systems needed to simulate and interrelate Logistics Systems Analysis Records (LSAR), human factors (HF), and MPTS variable do not yet exist. Computer-based technology is needed to: 1) develop data models to facilitate HF and MPTS analysis, 2) enhance the capabilities of current human/machine interface models (man modeling); 3) expand the range of human factors criteria that can be estimated and evaluated in a CAD/man-modeling environment (with emphasis on the impact of human/machine interfaces); 4) integrate these advanced task analytic methods data systems, and analysis tools into a user-oriented, CAD-based, LSAR/HF/MPTS analysis workstation (capable of simulating man machine interfaces and the implications of job design alternatives; and 5) develop design relevant evaluation criteria for use in assessing the merit of proposed human/machine interfaces (for use in contract evaluations). Such a system would enhance and expand the utility of computer-assisted design for the evaluation of human/machine interactions. Ideally, it would link up Logistics Systems Analysis Records (LSARs)--the major source of manpower, personnel training and safety MPTS data--with computer-assisted design (CAD)--the major tool in equipment design. It would also make extensive use of human factors (HF) simulations and data bases. Expert systems to facilitate human factors decisions would be an important part of the total system; and the CAD-based LSAR/HF/MPTS analysis workstation would be used to graphically simulate alternatives. Demonstrations of component systems that could be used in the design of MPTS-tradeoff-oriented workstations (e.g., MPTS requirement analysis systems, CAD systems, data bases, and expert systems for MPTS tradeoff decisions) are appropriate responses to this announcement. Phase I will demonstrate the feasibility of a comprehensive computer-based system for simulating MPTS tradeoffs in the weapon system design process. Phase II will produce a "demonstration system" of the above MPTS-Tradeoff Workstation.

AF91-063 TITLE: Life Support Systems Development

OBJECTIVE: Develop advanced systems to provide life support for aircrew of high altitude/performance aircraft.

DESCRIPTION: Specific areas include: (Specify subtopic by letter)

a. Aircrew of high performance fighter aircraft capable of sustained 9-G and high altitude aircraft capable of altitudes >60K, have unique requirements providing for their basic physiologic functions to allow them to perform at an adequate level. Frequently this performance requires man-machine interface at a highly technical level; i.e., a compromise in performance results in a less than satisfactory equipment function. These environments include high-thermal stress, high-sustained $+G_z$ exposures of 9-G for 30 seconds, long-term continuous operations, hypobarism, rapid decompression, laser eye hazards, and chemicals of warfare. Although protective methods and systems are available for these extreme environmental changes, they frequently do not provide adequate protection to allow aircrew optimal performance. These operational systems frequently need to be refined or new solutions provided. Examples of solutions are protective garments, equipment or methods, systems models, and exposure tables. Phase II will result in prototype hardware that will be transitioned to the HSD Acquisition Group for further operational development.

b. Develop advanced decompression/denitrogenation computer systems for real time and predictive decompression sickness risk assessment. High altitude exposure in aircraft, hypobaric chambers and extravehicular activity (EVA) in space result in an inherent risk of decompression sickness (DCS). In the past, general guidelines for safer altitude exposures have been developed through costly time-consuming studies, each specific to unique altitude exposure scenarios. The results of these studies are often difficult to apply to new altitude requirements. Therefore, new, time-consuming studies must be undertaken. Rapidly changing technology in aircraft design dictates improved decompression risk assessment capability. Data bases exist at USAFSAM that contain information necessary for the development of a standardized altitude decompression/denitrogenation model. Such a

standardized decompression software package will permit hardware development for altitude decompression computers. These computers are needed for both real-time DCS risk information as well as DCS risk predictive capabilities. Phase II will result in prototype hardware that will transition to the Acquisition Division for further operational development. Utilization of such hardware is anticipated in aircraft cockpits, or hypobaric chamber control stations, in EVA suits, and as high altitude mission planning computers.

AF91-064 TITLE: Dosimetry Technology for Radio-Frequency (RF) Radiation-Induced Currents and Temperature Increases

OBJECTIVE: Develop systems to measure induced currents and temperature increases in humans exposed to radio-frequency fields.

DESCRIPTION: Specific areas include: (Specify subtopic by letter)

a. Develop systems to measure currents induced by RF fields in humans. It has been shown recently that vertically polarized radiofrequency fields in the VLF-VHF band (10 kHz-100 MHz) are capable of inducing fairly significant body currents in a freestanding human being. A second problem in the VLF-VHF band of frequencies is that commonly encountered ungrounded metallic objects such as a car, van, bus, etc. will develop open circuit voltages on the order of 30-100 Volts when objects are exposed to incident electric fields of 100 V/m. Voltages are proportionately higher for larger incident fields. Upon touching such objects, large currents on the order of hundreds of milliamperes may instantaneously flow through the hand, the arm, and the body. To reduce such problems, limits on these currents have been proposed by International Radiation Protection Agency (IRPA) of the World Health p4@0 Organization and the Ministry of Health and Welfare of Canada. Limits on currents through the feet and through the body upon contact with ungrounded metallic bodies are also in the process of being promulgated by ANSI C95.4. Instrumentation for determination of induced electrical current in humans is needed so that assurances can be given that the compliance requirements of the new ANSI standard at low frequencies are being meet. Current probes should be self-contained, compact, and wearable.

b. Although a probe and system for temperature measurement in radio frequency radiation (RFR) fields are commercially available, there is not an interface to standard laboratory computers. The computer interface will provide an easily implemented method for accurate temperature measurements which are used for two purposes in RFR experiments: 1) The temperature of the preparation is, of course, needed to document experimental conditions; 2) Initial temperature increase at the onset of RFR is used to determine specific absorption rate. The interface will be constructed using standard hardware components and have associated software written for its use. It is anticipated that the connection to the probe will be an appropriate analog-to-digital converter. However, a search must be performed to identify devices which facilitate communication with IBM PC compatible computers. The Phase I feasibility study will be a search for appropriate technology to allow computer interface between commercially available temperature measurement systems and standard computer systems. Initial designs will consider direct connection of a converter to the computer, such as the Intersil ICL7109. The search will also identify the most appropriate sensor board for a PC expansion slot. Phase II will produce an interface between temperature probe and computer.

AF91-065 TITLE: Noninvasive Physiological Monitors

OBJECTIVE: Develop a rapid, lightweight, mobile and easily monitored assay(s) to record and quantify physiological activity.

DESCRIPTION: Specific areas to be addressed include: (Specify subtopic by letter)

a. Many stressful events encountered by military personnel are manifested in the body by physiological events. For example, cortisol is released to generalized stress. Similarly melatonin may indicate level of fatigue, and glucose measures suggest energy and oxygen utilization. A noninvasive assay system for these and other physiological indicators is needed to quantify stress in a variety of situations. Since time is usually limited during stress, these assays would have to rapidly provide a reasonably close approximation of more sophisticated measures. The ideal system would use saliva or perhaps urine to register more than one physiological parameter in an easy-to-use-and-interpret monitoring device. For example, 1 cc of saliva in such a system might provide multiple assays. The numbers might be stored on microchip for later processing. Such a device would allow personnel to document their level of stress (fatigue or otherwise).

b. The Air Force needs a data acquisition and information-control system to monitor patients during aeromedical evacuation. Patients transported in this environment require frequent monitoring to determine their physiological condition as a result of their injury and their reaction to the transportation environment. We would like one system which can organize both conventional

physiological data (heart rate, EKG, blood pressure, etc.) and patient records (age, sex, injury history, etc.) with the possibility of including unconventional physiological data such as skin color, pupil size and reaction, and nail bed blanching. The idealized system would be able to monitor both patients and the aeromedical evacuation environment. Once patient data has been entered, the system should be able to organize it to monitor the patient's progress and cross-reference the information with a data base to predict probable current and future conditions (i.e., disease identification, possibility of altitude induced hypoxia, etc.). Current research has identified what type of patient records and physiological data needs to be acquired. Future research emphasis is to develop the hardware and software capabilities necessary to: 1) perform voice or handwritten data entry; 2) recognize and process unconventional information; and 3) cross-reference the acquired information with a data base to predict probable conditions. This research may be performed in segments or as a part of one complete system.

c. Research efforts are being sought to produce instrumentation capable of executing sophisticated signal processing software and interacting with test subjects in research projects to provide the noise exposure and human response data. Air Force planners require human response data to predict the effects of changes in flight operations along Military Training Routes (MTRs) and around firing and test ranges. Accurate prediction of the effects of sporadic aircraft overflight noise exposure on sparse populations living in these areas is constrained, however, by an incomplete understanding of the effects of aircraft noise on rural populations. Currently, data exists in a data base maintained at the Armstrong Aerospace Medical Research Laboratory to allow fairly accurate predictions of human annoyance at the community level around airbases. However, application of these data and the resulting Schultz (1978) curve, based on these data, to predict human responses to aircraft overflight noise is, in many situations, a debatable scientific procedure. Use of the Schultz curve data is questionable for the present application because of significant differences in the type and amount of noise generated and because of expected differences in human attitudes between people who live in an airport environment versus the MTR range environment. The most persuasive and useful data would link noise exposure and human responses at the time of the noise occurrence. Desired device characteristics are: 1) it must be small enough and sufficiently lightweight to allow it to be conveniently and relatively unobtrusively carried or worn for periods of days or weeks; 2) it must contain all of the electronics necessary to allow sensors and software to be effectively used for continuous monitoring, processing and analyzing of acoustic signals; 3) it must be capable of both passively accepting spontaneous human responses and administering a questionnaire at specified times or upon detection of an aircraft flyover; 4) the power source must provide sufficient resources to make the device self-sustaining during transport to remote areas, to make the required measurements and to retain the data for long periods of time; and 5) the per unit cost must be a primary consideration in the design strategy because a low cost device will allow the large number of individuals to participate in the study that are required for the results to be valid and reliable. Phase I should produce the "plan" for a personal noise dosimeter that meets the requirements outlined here. Phase II will produce a prototype (Brassboard) personal noise dosimeter.

d. Develop methods to remove or correct artifacts of physiological origin from psychophysiological data. The collection of ambulatory data from operators performing their daily tasks makes possible the monitoring of the effects of workload, time-on-task, fatigue and other factors. The main source of data artifacts is not electrical or magnetic interfaces from the environment but is rather physiological in origin and is produced by movement and muscle artifacts. These "physiological" artifacts are, unfortunately, difficult to deal with since they are in the same frequency range as the signals of interest which are heart rate, eye blink, EEG and respiration. In order to make the best use of "on-the-job" physiological data, these artifacts must be reduced at data collection and must be removed from the data of interest. Phase I product is evaluation of the problem and proposed solutions. Phase II product will be hardware and software implementation of the proposed solution.

AF91-066 TITLE: Medical and Neurophysiological Aspects of Aircrew Performance Capabilities

OBJECTIVE: Develop medical/neuropsychological models to predict human performance.

DESCRIPTION: Practitioners of Aerospace Medicine and Neuropsychology use a variety of clinical tests and procedures developed within the specialties of neurology, neuropsychology and the neurosciences to assess the basic human performance behaviors of aircrew. On the other hand, human factors scientists and engineers generally employ "stimulus-response" techniques to measure relevant task performance in objective terms. Resulting data are often used to derive "performance models" based on biomechanical, psychomotor, perceptual or manual control theoretical constructs. The Cognitive Scientist has the opportunity to integrate a rich "clinically derived" performance data base with the voluminous "human factors-derived" performance data base to develop robust models of such higher order behaviors as memory, pattern recognition, reasoning, decision-making and executive control functions. Continued progress in this domain requires a theoretical framework supported by reliable experimental and analytic tools to identify the relationships between observed performance behaviors and the underlying anatomically and functionally-based mechanisms. The product of Phase I shall be a first generation theoretical structure and conceptual design for appropriate experimental and analytic tools to bridge the gap between "behaviors" and "mechanisms." The product of Phase II shall be a refined theoretical structure with prototype experimental and analytic tools, demonstrated in a research environment. A

potential Phase III could result in marketable test devices and analytic procedure software tools derived from Phase II. These products could have wide ranging applications in both civilian and military enterprises for screening applicants for specific jobs, evaluating training systems and outcomes, detecting/predicting performance aberrations and specifying man-machine interface designs.

AF91-067 TITLE: Helmet/Head-Mounted Systems Technology

OBJECTIVE: Develop virtual-world or helmet/head-mounted display applications for aircrew operations and/or training.

DESCRIPTION: Proposals in this area should include the specific subtopic (by letter) as indicated below:

a. Investigate and establish the suitability of night vision goggles (NVGs) to provide nuclear flashblindness protection. Phase I is an initial paper study to estimate both eye protection capability and NVG resistance to damage. If result is encouraging, perform additional studies and (Phase II) design/integrate/brassboard NVGs with Lead Lanthium Zirconium Titanate (PLZT).

b. Enhance pilot daytime passive visual search with the integration of Low Powered Binoculars (2.5X to 7X) with the standard USAF lightweight helmet (55- P). Design, test and evaluate these devices as installed on USAF 55-P helmets and as worn by human subjects or pilots with 20/20 corrected vision.

c. Integrate an instrument to nonintrusively measure visual accommodation and ocular vergence with a helmet-mounted display (HMD). Phase I objective is to breadboard a helmet-mounted optometer for a laboratory proof-of-concept demonstration. The optometer must be lightweight, compact and capable of being incorporated into an HMD with little or no modification. The required resolution and accuracy of the optometer is 0.125 diopter. The resolution and accuracy requirement for vergence measurement is 0.1 degree. Both requirements shall be maintained throughout a 60 degree diameter circular instantaneous field of view. Phase II will prototype two functional brassboards meeting the above requirements, plus potentially destructive flight qualification tests.

d. Design, evaluate and prototype a passive optical sensor system for aircraft altitude determination based on optical flow fields. Phase I consists of 1) overall system architecture; 2) sensor requirements; 3) signal processing and computational requirements; and 4) expected performance under nominal and degraded conditions. If feasibility is demonstrated, Phase II would develop and evaluate a working prototype.

e. Prototype a helmet-mounted virtual image display (VID) without see-through for supporting man-machine interface research. Phase I shall concentrate on design and proof-of-concept demonstration of a helmet-mounted virtual image display, using two color image sources to provide a true three-dimensional world. Initially, resolution requirements will be only Color Graphics Adaptor (CGA) compatible, but eventually the virtual environment will include high resolution graphics, so there should be a plug-in capability for future color image sources. The optics should be free of geometric distortions, so predistortion of image input is obviated. Field of view goal is 120 degrees horizontal (H) by 90 degrees vertical (V), with a minimum requirement of 80 H by 60 V. Phase II will assemble three fully functional lab breadboards for display/optical performance verification.

AF91-068 TITLE: Ergonomics/Perception

OBJECTIVE: Improve crew systems via techniques for acquiring, interpreting, visualizing and applying ergonomic and perceptual data.

DESCRIPTION: Within this topic we encourage proposals in the following areas: (Specify subtopic by letter)

a. Develop prototype automated 3-D full body, anthropometric measuring system. Technological advancements in design and manufacturing systems allow for automated production of clothing and protective equipment. These systems operate in a three-dimensional environment and need three-dimensional data as input. Therefore, to use them effectively, three-dimensional human body surface data is required. A system is needed to obtain high density, 3-D data on the entire surface of the human body, including areas which might be masked, such as under the arms. It must acquire and display data rapidly and be readily transportable as it will be used for anthropometric surveys at widespread locations. A number of technologies are available to produce such a system, so Phase I would entail assessing the various techniques for this particular application. During Phase II a prototype system will be built and evaluated.

b. Analyze the visual mechanisms underlying the discrimination of small structured targets at supra-threshold contrasts. The

human visual system's capability to detect and discriminate objects is based in part on the luminance and chrominance differences between the object and its surround. The relative contributions of the luminance and chrominance mechanisms in mediating detection and discrimination varies as a function of the spatial and temporal properties of both target and background (King-Smith and Carden, 1976; Finkelstein and Hood, 1982). To the developer of camouflage, concealment and description (CCD) techniques, such observations are critical. Presently, the luminance and chrominance contributions to the discrimination of small structured targets in spatially complex backgrounds is poorly understood at supra-threshold levels. This topic seeks development and implementation of innovative approaches to determining these relative contributions (Phase I) in a manner which will facilitate the development of optimal camouflage techniques (Phase II).

AF91-069 TITLE: Manikin for Injury Assessment

OBJECTIVE: Develop manikin instrumentation and complementary criteria for relating measured responses to human-injury likelihood.

DESCRIPTION: The Air Force has developed an Advanced Dynamic Anthropomorphic Manikin (ADAM) for use in testing and evaluating the performance of ejection and protection systems. The final design report is available from DTIC. While this manikin has been designed to have humanlike properties, its application emphasis has been on determining the effects that a human body would have on an aircraft system rather than the effect that the system would have on man. This effort would seek to develop manikin-integrated sensing and instrumentation methods to measure responses relevant for assessing hazards associated with aircrew force exposure environments. Additionally, it would develop appropriate criteria for injury likelihood prediction as a function of the manikin measured responses. Injury of the long bones and joints during limb flail, and of the neck and spine during vertical acceleration and windblast exposure are among the areas of most concern. While it is desirable that this methodology be compatible with the designs of the ADAM, the current ADAM design should not constrain the proposal of different approaches that can better satisfy the overall objectives. Phase II would involve incorporating the methodology developed in Phase I into prototype manikins (or manikin segments) and demonstrating by tests the validity of the approaches.

AF91-070 TITLE: Human Sensory Feedback in Air Force Telerobotic Systems

OBJECTIVE: Develop sensory feedback modes and subsystems for intuitive operation of robotic systems by human operators.

DESCRIPTION: Concepts for human control of robots in unstructured Air Force environments combine the cognitive abilities of the human with the hardiness and heavy manipulation capabilities of robots. By capitalizing on the human judgment and the robot's ability to operate in conditions lethal to humans, the advantages of each "system" can be exploited. Human operator awareness (feedback) of the robot's work environment adds significant flexibility to mission capability. The challenge is to develop quality feedback from the robot to the operator. Two specific current challenges are: 1) Feedback Control: Control instability may be encountered when the operator feedback control mode switches from position control (low impedance) to force control (high impedance). Techniques must be developed to minimize the impact of this nonlinear transition on the human feedback mechanism and mechanical system response; 2) Force Feedback to Small Exoskeletons: Fine manipulation using human sized robotic hands requires human sized exoskeletons for intuitive control. Force feedback to these small exoskeletons requires small volume, high efficiency semilinear actuator mechanisms. Actuators are needed to provide human range forces to exoskeletal systems used by operators of fine dexterous manipulators. Phase I will produce sensory feedback techniques including improved feedback control to operator and force feedback to small robots. Phase II will result in brassboard hardware employing these techniques, capable of integration with current and planned exoskeletal systems.

AF91-071 TITLE: ATLAS to Ada Software Compilation System

OBJECTIVE: Develop an Abbreviated Test Language for All Systems (ATLAS) software compilation system which can translate validated ATLAS test specification statements into Ada test program code.

DESCRIPTION: ATLAS has been the DoD standard test programming language since the mid 1970's. ATLAS has also been adopted by the airline industry as the standard test programming language. There is a current DoD inititative to adopt Ada as the standard test programming language. The government and industry have invested large amounts of money and time into the development of ATLAS test development and documentation tools that do not currently exist for Ada. To effect a smooth transition to Ada, an ATLAS software compilation system is needed that produces Ada test program code to maximize the use and benefit of existing ATLAS tools and expertise while gaining the additional benefits of Ada as a test language. Since there are numerous versions of ATLAS in the DoD and commercial marketplace, offerors should outline how each version can be accommodated in the proposed system to facilitate current vertical integration initiatives in the DoD. Consideration should be

given to the modular modification of existing ATLAS compiler products versus new development. By modifying an existing modular ATLAS compiler, much of the validated compiler design can be retained, thus reducing the risk of development and the time required to field a mature product. An important consideration for selection will be the completeness of the solution, probability of success, and the ratio of investment to product value. Phase I will analyze existing ATLAS compiler products, assess the feasibility of an ATLAS to Ada compilation system, and develop the Ada architectural design for implementation. Phase II will involve the modification of an existing ATLAS software compilation system to produce the Ada test program code, development of the Ada test program architecture, validation of the compilation system and the integration and demonstration of a simple test program set on a selected Air Force Automatic Test Equipment System. Phase III would involve the expansion of this compiler product into a total Ada environment for tests

AF91-072 TITLE: Halon Replacement

OBJECTIVE: Develop a replacement for Halon 1211 and Halon 1301.

DESCRIPTION: The Montreal Protocol eliminates the production of chlorofluorocarbons (CFCs) in the United States by the year 2000. Halon 1211 and HALON 1301 are CFCs used by the Air Force for fire suppression. Halon 1301 is dispersed as a gas and is used for aircraft fire protection. Halon 1211 is dispersed as a liquid and is used for ground fire fighting. A substitute needs to be developed for both agents. Phase I will identify potential replacement agents which can extinguish fire but are not hazardous to the environment. Phase II will test each potential agent to identify a substitute(s).

AF91-073 TITLE: New Canopy/Windshield Design to Extend Life of Cockpit Displays

OBJECTIVE: Develop a technology to enable effective control of cockpit ambient light environment.

DESCRIPTION: Cathode Ray Tubes (CRTs) have, until recently, held the monopoly in providing electronic portrayals of aircraft status and tactical functions to the pilots of military aircraft. Now, a new generation of color CRTs and flat panel/dotmatrix displays are arriving on the scene. Today, new Air Force aircraft systems (ATF, C-17, etc.) are designing their respective cockpits to embody these electronic display instruments. Retrofits of existing inventory aircraft are being planned that will incorporate this new generation of electronic display instruments. Regardless of the display instrument technology being employed, the problem remains the same. Namely, to be readable, the instruments have to be driven at or near their peak light-output (brightness) performance in order to at least marginally compete with the sunlight that, directly or indirectly, enters the cockpit. This mode of operation causes significantly higher operating temperatures of these subsystems and results in a direct, adverse impact on their reliability and frequency of maintenance.

A means of controlling these high-ambient light conditions in military aircraft cockpits would eliminate the preceding, abusive, operating mode. This is believed to be attainable via canopies (transparencies) and windshields whose light-transmission characteristics can be varied to suit the ambient light conditions. Such "variability" would significantly reduce ambient light levels in the cockpit; and, could be achieved either automatically or under a manual control that is adjusted by the pilot. The latter is preferred; however, either method, or a combination of the two is acceptable. As an objective, in ambient light environments up to one-hundred foot candles, the transmittance of the canopy and windshield should be 75% to 85%; a figure that is similar to present-day canopy and windshield light-transmittance characteristics. Above an ambient light level of two thousand foot candles, the transmission of the canopy and windshield should be 15% to 20%. A continuous gradual, transition should exist for ambient light levels that are between the two aforementioned limits. Also, under any of the ambient light conditions, smooth gradations in light-transmission uniformity across the entire canopy and windshield area, of up to 15%, will be acceptable. The light transmission characteristics of such canopies and windshields would, ideally, not alter the color spectral distributions of the light emitted and reflected by real world objects; nor, would they spatially distort or scatter light passing through them. A non-fluid method for achieving the "OBJECTIVE" is preferred. The proposed method should include a discussion of its impact on the service life of the canopy and windshield. It is also important that the proposed method allow fora "fail-safe" mode that would assure maximum transmittance of light in the event of component degradation or failure. Phase I should validate the concept, preferably through lab demos. Phase II would embody Phase I principles in actual canopy/windshield configurations.

AF91-074 TITLE: Aircraft Power - More Electric Concepts

OBJECTIVE: Develop electric power-by-wire concepts to replace conventional aircraft power system components.

DESCRIPTION: The goal of the More Electric Aircraft initiative is a doubling of aircraft power reliability by the minimization or

elimination of troublesome systems such as: centralized hydraulics, gearboxes, and pneumatic bleed systems. Additional benefits possible are weight reduction, increased survivability, and reduced heat rejection to the fuel. In the near term, power can originate from gearbox mounted generators, be distributed through a "smart" fault tolerant electrical system and supplied to the various loads. The power will be 270VDC, and the system will have the capability to sense faults or damage and reroute power to the highest priority loads, for example, the flight controls. Extensive built-in test capability can be utilized to ease maintenance actions, and "crud parts" items such as electrical connectors and wiring will be addressed. In the far term, the generators can be buried in the main engines to eliminate the engine and airframe mounted gearboxes. A switched reluctance type generator can be used because of its solid core, fault tolerance, and higher temperature capabilities. It is planned to have the power controls mounted outside the rotating engine core, so that the generator core and windings inside the engine will have a mean-time-between-failure approximately ten times that of the engine. A study will be conducted to determine required improvements in existing components (crud parts) and to define new components which will be needed by More Electric Aircraft. Development and demonstration of many new component technologies is needed for the More Electric Aircraft concept including a wide variety of electical equipment for 270VDC power generation, distribution and utilization functions. Advanced high temperature (200-1000°C) electric wire insulation, high power connectors, solid state power controllers, inductive switching, built-in-test architectures and components, large electrical starter/generators, fault tolerant electric power distribution components and high temperature (greater than 300°C) magnetic materials are needed. A wide variety of electric driven actuator technologies for a large spectrum of aircraft functions/subsystems is also required. Phase I goals include study results, analytical derivations and proof-of-concept experiments. Phase II goals include high temperature prototypical hardware demonstrations. Work to be accomplished in Phase III includes component integration, test, assessment and comparison to analytical models.

AF91-075 TITLE: Development of Aluminum Rivet for Use in 900°F Aluminum Structure

OBJECTIVE: Demonstrate a highly sustainable aluminum fastener technology for use at temperatures of 900°F or above.

DESCRIPTION: Future high performance aircraft systems will demand structure that is lightweight and durable at high temperatures. For lightweight metallic structures, this demand is driving the use of aluminum to higher and higher temperatures. Naturally, with the high demand for increased readiness, sustainability, reliability, and decreased workload maintenance, unreliable aircraft structures resulting from fabrication of component assemblies using incompatible materials and fastener systems cannot be tolerated. Incompatibilities result from a difference in thermal expansion coefficient, galvanic corrosion characteristics and the like. This enhances the likelihood of unreliable, leaky structures as well as reduced durability and fatigue induced failures. The results of a Phase I and II small buiness innovative research (SBIR) effort, "Development of an Aluminum Fastener System for Use at Moderate Elevated Temperatures (~600°F)", indicated that it was feasible to make a 600°F aluminum fastener which compared favorably with A286 steel fasteners. The 600°F aluminum fastener is favored over A286 for use in lighterweight aluminum structures at higher temperatures due to improved compatibility and high temperature fatigue resistance. The aluminum material systems used in those programs show potential for enhanced elevated temperature strength and performance however, even higher temperatures are achievable for aluminum. A number of mechanically alloyed systems using intermetallic dispersions of Al_4C_3, Al_2O_3 and Al_3Ti are presently being developed to move the service temperature for aluminum up to 900°F. Accordingly, the objective of this effort is to assess the feasibility of forming 900°F aluminum materials into fasteners for use in 900°F aluminum structure. The fasteners developed should also be compatible with other aluminum alloys and titanium alloys. Phase I will be concerned with alloy screening, quality assessment, feasibility and alloy(s) screening and selection. Phase II shall involve optimization of processing and material systems coupled with fabrication of coupons and generation of design allowables. In addition, Phase II emphasis should be placed on achieving small or subscale technology demonstration of equivalent or better performance (e.g., in terms of sustainability and reliability) than state of the art materials systems (e.g., A286), as well as payoffs in cost and weight.

AF91-076 TITLE: Hook-loop Attachment Concepts for Structural Doors and Access Panels

OBJECTIVE: Identify and evaluate concepts for fastenerless hook-loop attachment of structural doors and access panels.

DESCRIPTION: The skin of virtually every Air Force weapon system is covered with numerous doors and access panels. These doors and panels are frequently removed to service subsystems and the airframe. The majority of these doors and panels are attached using traditional mechanical fasteners including bolts, screws, and rivets. In addition heavy doublers, nutplates, and collars are required to build up the structure to lower stress concentrations in the fastener holes. The problems with traditional fasteners are well documented. Door and panel removal requires removal of all the fasteners and the reinstallation of the fasteners when the door or panel is put back in place. Removal and installation of the fasteners is time consuming, and oftentime leads to maintenance induced damage (MID) from tool slippage, over-torquing, use of the wrong fasteners, use of the wrong tool, etc.. In harsh environments the removal and installation problems are compounded. The entire process is costly and reduces

system readiness and sortie generation capability. For stealthy vehicles fasteners increase signature. This program will develop a hook-loop (analogous to the trade name Velcro material) fastening concept which uses no traditional mechanical fasteners. No holes, doublers, nutplates, and collars are required in the airframe and panel. Doors and panels held with hook-loop attachments can be removed and installed in one simple step. The hooks and loops are permanently attached to the faying surface of the airframe and panel, and cannot be dropped or lost, leading to foreign object damage (FOD). Problems of fastener over-torquing and using the wrong fastener will also be eliminated. The products of Phase I should include evaluation of hook-loop fastening material properties, identification of door and panel applications, design concepts, operational concepts, quantification of payoffs, and proof of concept through small scale testing. In Phase II full scale doors and panel should be fabricated and tested.

AF91-077 TITLE: New Aerospace Wire Insulation Materials

OBJECTIVE: Develop new wire insulation materials for aerospace applications.

DESCRIPTION: Wire insulations currently available cannot meet all identified performance requirements for aircraft and space applications. New insulations based on organic or inorganic materials are required. Current aircraft have experienced wiring failures which can degrade system performance. Future aircraft will most likely operate at higher voltage and temperature levels. Problem areas include resistance to arc propagation (270 volt D.C. faults), abrasion resistance, limited loss of mechanical and electrical characteristics at high temperatures (over 2500C), fluid resistance, and handling properties. Proposed materials should exceed the performance of currently available military wire insulation constructions. It is expected that new materials will be developed as candidate round and flat wire constructions. Phase I should examine existing materials, modification of materials and the potential design of new materials. Preliminary research suggests that the following polymeric materials may be of interest: fluorinated polyimides, phenylated polyquinolines, polysiloxaneimides, fluorocarbon-hydrocarbon copolymers, organo-ceramic polymers, and polybenzoxazoles. This effect should examine the feasibility of obtaining identified materials and provide a discussion on their potential advantages over existing materials. A Phase II effort would characterize selected materials and evaluate finished wire constructions for use as an aerospace power distribution system.

AF91-078 TITLE: Advanced Coldplates for Line Replaceable Modules

OBJECTIVE: Design and develop a light-weight, low-cost, highly thermally conductive composite coldplate.

DESCRIPTION: Avionics functions are contained in line replaceable modules (LRM), which are housed in integrated racks. These LRMs consist of electronic componenets, printed wiring boards (PWB), coldplates, connectors, and thermal clamps. The key component is the coldplate. The PWBs containing the components attach to this plate. The connector, which is the electrical interface to the rack, attaches to the coldplate. This plate is also the thermal interface to the rack. The coldplates in today's systems are typically 1/8" thick aluminum. This is a heavy material and has a high thermal resistance. More importantly, the coefficient of thermal expansion (CTE) for aluminum is substantially different from that of PWB material used in the construction of circuitry (e.g., silicon, ceramic). This CTE mismatch is a significant cause of avionic failures due to interconnect separation and PWB delamination and cracking. Also, aluminum adds avionic weight to the aircraft system and allows the electrical components to run at a high junction Temperature (TJ). For example, the junction temperature for a 50-watt, dual-sided PWB will increase by about 120C due to the aluminum plate alone. This increased temperature reduces the life of many circuits by almost a factor of 2. The reliability of these components as well as the LRM would be increased dramatically if the thermal conductivity of the coldplate can be increased. Coldplates of light-weight materials will reduce the total avionics weight which in turn reduces life cycle costs. Phase I activity will include characterizing different materials for coldplates, performing trade studies (thermal, weight) of various materials, and recommending several candidate materials. Phase II activities will be the detailed design, prototype development, and testing of a light-weight, low-cost, highly thermally conductive LRM coldplate.

AF91-079 TITLE: New Concepts and Innovations for Aeronautical Systems/Subsystems

OBJECTIVE: Develop new concepts and innovations for aeronautical systems/subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of aeronautical systems/subsystems research, development, and acquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific aeronautical topics. This general area covers the full spectrum of Air Force aeronautical missions (i.e., tactical, airlift, mobility, strategic, training, etc.). Emphasis is placed on potential long term planning concepts. Topics as diverse as new weapon system concepts and improved operational techniques can be submitted. Innovations in technologies that are currently available only from foreign sources or from limited sources in the United States are specifically encouraged. Additionally, innovative proposals which address Logistic Technology Needs are encouraged. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF91-080 TITLE: Methodology for Premilestone I Planning

OBJECTIVE: Devise/develop effective methodology for use in Premilestone I planning.

DESCRIPTION: This category of Premilestone I planning methodology is intended to cover three specific areas of interest in FY91. They are outlined as follows:

a. Premilestone I cost estimating from emerging technology to the fielding of weapon systems/subsystems employing these technologies is required. This will provide the wherewithal to cover specific technologies and then accumulate the cost of these technologies into a total systems/subsystems cost model. Examples of technologies of interest are: High temperature materials, ultra-light airframes, smart skins, high performance turbine engines, advances avionics, STOL/VTOL technology, and advance manufacturing technology, which support the development of (hypersonic, supersonic, STOL/VTOL, special operations, etc.) systems/subsystems should be addressed individually and in combination for a specific system application.

b. Develop software based systems to facilitate information structure analysis, function analysis, and dynamic performance analysis for the planning and requirements studies needed for the design and development of systems. Data collection and storage performed for problem definition and analysis, enterprise, system description, and requirements analysis for design and development is a critical phase of the planning process.

c. In the area of design and mission analysis methodology tools specific requirements exist to develop an effective methodology to determine the susceptibility of USAF intratheater airlifters to conventional threats (i.e., artillery, multiple launch rocket system, small arms, etc.) during ground operations such as loading, offloading or ground refueling. Determination of susceptibility as a function of time on the ground is vital. The impact of environmental factors such as terrain, weather, day/night operations must also be taken into account.

AF91-081 TITLE: Innovative Applications of Artificial Intelligence to Emerging Systems

OBJECTIVE: Support the development of system/subsystem concepts to locate, identify, and attack Strategic Relocatable Targets (SRTs) and Large Area Displays for cockpits for future strategic, tactical, and airlift systems.

DESCRIPTION: This category of innovative concepts is intended to cover application of all facets of artificial intelligence. It is meant to provide the innovator with latitude to focus on areas of application not addressed by other specific aeronautical topics. All aspects of artificial intelligence (i.e., knowledge representation, innovative architectures, expert systems, neural network, etc.) as applied to all aspects of the Air Force mission are to be considered. Special emphasis is placed on AI application to Large Area Displays, which give total situational awareness information to the aircraft cockpit as well as location/identification/attack of SRTs.

AF91-082 TITLE: Future System Concepts and Related, Innovative, Analysis Tools

OBJECTIVE: Develop new concepts in the application of emerging technology and develop analytical tools for evaluating these emerging systems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of system application concepts and analysis techniques for future emerging aircraft systems. These emerging systems include: The Advanced Theater Transport (ATT), Special Operations Aircraft (SOA) for long range infiltration/exfiltration/resupply airlift; training system for T-37 and T-38 replacement; Advanced Multi-Role Combat Aircraft (AMRCA); Aerial Refueling Systems for future tanker replacement; and Single Stage to Orbit (SSTO) system concepts. Of special interest are concepts and analytical tools related to the detection, location and attack of Strategic Relocatable Targets (SRTs). Analytical tools are to include areas of design analysis, design synthesis, mission analysis, mission effectiveness, and supportability analysis for subsonic to hypersonic system development. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF91-083 TITLE: ARIA Cruise Missile Trajectory Planner/Plotter

OBJECTIVE: Develop innovative, timely methods to plot cruise missile trajectories and generate/plot ARIA aircraft profiles.

DESCRIPTION: The Advanced Range Instrumentation Aircraft (ARIA) currently supports several cruise missile test programs by receiving, recording, and relaying telemetry data, as well as providing Remote Command and Control/Flight Termination System (RCC/FTS) coverage. Each program has peculiar requirements and uses different test ranges to accomplish its respective mission. It takes approximately five man-hours per hour of cruise missile chase to plan an appropriate ARIA support profile. This equated to one person working full time for about 18 weeks to plan the cruise missile mission supports for 1989, and the number of missions per year is increasing. A planning/plotting program would allow more efficient use of manpower and reduce response time to new missions and mission changes. This concept requires a system to plot segments of the cruise missile trajectory on different scales of aeronautical charts. The system must be able to accept input in the various formats (tape, disk, etc.) provided by each program. The system must also be able to input the data manually. Each waypoint and time must be identified on the support profile. The profile must be within the ARIA aircraft performance limits and mission support requirements. Both these factors will be different on the EC-135E and the EC-18D aircraft. Support requirements will include distance from the missile, relative position of the missile to the ARIA, relationship of relative position to the attitude of the ARIA, and specific airspace restrictions for different operating areas. The missile track and the ARIA track must be able to work with information up to and including Secret-SAR. Phase I will consist of the feasibility demonstration and delivery of a preliminary modeling program mapping a cruise missile trajectory and the associated ARIA aircraft tracking profile. Phase II will be additional work to perform the full scale demonstration of the program so that the operating parameters and system capabilities are verified against known system limitations.

AF91-084 TITLE: Tactical Modem for Stealth Communication (TMSC)

OBJECTIVE: Develop a modular, expandable, parallel-processing modulator/demodulator for Stealth/Anti-Jam (AJ), adaptive, tactical communications.

DESCRIPTION: The trend towards intelligent jamming mandates demands that future tactical communications systems possess Electronic Counter-countermeasures (ECCM) responsive formats. The ECCM response to interference must be real time and adaptive to maximize the probability of successfully receiving a message. In addition, the adapted transmission must be transmitted in a burst to enhance the Low Probability of Intercept (LPI). A modem processing modular architechture is needed that supports up to 50 MHz input sampling rate while providing the needed adaptive processing. The module must be able to adapt its demodulation processing to received signals which may be corrupted by real-world interference and distortion. It must also be able to adaptively select the best available modulation scheme to optimize the LPI/AJ performance in real time. Under Phase I of the proposed research, the basic system architecture would be identified and a top-level system design developed; analyses would be conducted to establish system performance capabilities, the technologies necessary to accomplish implementation would be identified; the estimated weight, power consumption and volume of such a system would be estimated; critical technologies would be identified; and a final report, including a development specification, would be provided. Under Phase II of the proposed research, the contractor will fully develop breadboard real-time TMSC. The system shall be thoroughly evaluated through computer simulation. The effort will culminate in a laboratory demonstration which clearly demonstrates real-time adaptation. The contractor will deliver a final report which documents the system as well as future enhancements. The contractor will also deliver the software developed during Phase II.

AF91-085 TITLE: A Complexity Measure for Avionics Software (CMAS)

OBJECTIVE: Develop the capability of measuring the complexity of avionics software.

DESCRIPTION: As avionics systems become more sophisticated and their capability increases, the software designed for these systems has become more complicated. Therefore, the need arises for minimizing software complexity so that the design and support personnel can comprehend how the system works. In order to minimize complexity, it first needs to be measured. The use of complexity metrics will aid in deciding what software implementations will be used in the system. A decrease in future software support costs will be realized by less complex software implementations. This work will provide the Air Force with the capability of measuring the complexity of the avionics software by examining the size, features, and structure of the avionics source code. Work performed under this effort can be divided into two phases. The first phase will identify concepts that currently exist in measuring complexity that can be applied to avionics software. New techniques will be defined in this phase. The second phase will emphasize the development of a system for automating the process of measuring complexity of avionics software.

AF91-086 TITLE: Low Probability of Intercept/Jam-Resistant (LPI/JR) Burst Communications (BURSTCOMM)

OBJECTIVE: Develop and evaluate new and unique concepts for an LPI/JR, burst, radio-frequency, communication system.

DESCRIPTION: Present aircraft communications are detectable at long distances, and when stealth is required, the solution has been to go with communications out. This practice greatly reduces coordination and flexibility and increases the chances for confusion, ineffective missions, and accidents. New LPI/JR communication systems that are both affordable and broadly applicable to a wide range of aircraft and scenarios are needed to support modern Air Force operations. Envisioned applications include air lift, refueling, reconnaissance, and tactical and strategic defense/offense. Spread spectrum methods such as frequency hopping and direct sequence have been widely known and researched for a long time, but the primary emphasis with these techniques has been JR. Recognizing the growing importance of LPI communications, the Wright Research and Development Center has been investigating new adaptive and alternative spread spectrum communication approaches. One attractive method is burst communications. Transmitting with random short bursts, or burst time hopping, reduces the interceptor's ability to integrate the received energy which increases the detectability threshold. However, burst communications alone will probably not provide a worthwhile increase in LPI/JR performance over conventional spread spectrum methods. Some hybrid combination of burst time-hopping, frequency-hopping, direct-sequence, and/or other techniques will likely be required. Under Phase I of the proposed research, the contractor will study, design, and develop quantitative performance measures for an LPI/JR burst communication system capable of reliably transmitting low data rate/voice information between multiple aircraft. The system will be capable of operating over line-of-sight communication distances commensurate with the above applications. At the conclusion of Phase I, the contractor will deliver a final report documenting the selected design, performance analysis, and recommendations and a Phase II. Under Phase II of the proposed research, the contractor will design, fabricate, test, and deliver a transmitter and a receiver breadboard which demonstrate the selected LPI/JR burst communication concept. At the conclusion of Phase two, the contractor will deliver a final report documenting the design, all results, and recommendations for future enhancements.

AF91-087 TITLE: X-Band, Air-to-Air Radar, Sidelobe Clutter Mitigation Through Adaptive Processing

OBJECTIVE: To formulate and evaluate adaptive processing techniques capable of cancelling sidelobe clutter from tactical fighter pulse Doppler radars.

DESCRIPTION: Attainment of militarily useful all-aspect angle target detection and tracking ranges in difficult ground clutter and electronic countermeasures (ECM) environments against low observable (LO) threats will be technically challenging for several reasons. First, utilization of the classical all-aspect angle, medium pulse repetition frequency (PRF) look-down waveform results in the requirement for target detection in the presence of directly competing, diffuse sidelobe clutter, which can mask or obscure low radar cross-section (RCS) targets. Secondly, the number of sidelobe clutter discretes, that are capable of producing false alarms in conjunction with either the regular antenna sidelobe structure or a radome reflection lobe, will increase in direct proportion to the reduction in threat RCS. Finally, orders-of-magnitude reduction in target RCS will result in corresponding orders-of-magnitude reduction in target signal-to-sidelobe jammer ratios unless adaptive sidelobe cancellation (ASLC) is employed. However, the presence of sidelobe clutter can greatly degrade the performance of conventional ASLCs and, conversely, ASLC operation will serve to raise the rms antenna sidelobe levels, further aggravating the sidelobe clutter problem. Straightforward techniques to reduce directly competing sidelobe clutter in a medium PRF resolution cell include smaller range gate and Doppler filter widths, reduced antenna rms sidelobe levels, optimized medium PRF or alternative transmit waveforms, and significantly more sophisticated guard antenna false alarm reduction concepts. These will be effective to a degree. However, radar antenna installation under a radome can negate much of the potential performance gain. More exotic approaches, such as design or calibration of the antenna/radome assembly to result in lower installed rms sidelobe levels have yet to be developed, and are likely to be costly. With the tremendous increases occurring in digital signal processing technology, airborne radar adaptive processing is rapidly becoming practical and affords the potential of mitigating the sidelobe clutter. The Phase I activity will investigate exploiting adaptive processing to solve the all-aspect angle look-down radar mode diffuse and discrete sidelobe clutter problems and the ASLC/sidelobe clutter signal processing compatibility dilemma. The scope of the effort includes formulating and evaluating relatively simple (Doppler filtering followed by spatial nulling of competing sidelobe clutter patches) and highly complex (joint jammer and sidelobe clutter cancellation in a single processing node via space-time techniques) radar architectures. The Phase I output will consist of an adaptive processing algorithm design, radar architecture definition, and digital computer simulation performance predictions including "on aircraft" effects. These activities will lead to the Phase II effort demonstrating adaptive processing sidelobe clutter mitigation (goal of two orders-of-magnitude over conventional techniques) in near real-time using breadboard digital array signal processors and appropriate radar receiver/antenna hardware/emulations and tactical environment simulations.

AF91-088 TITLE: Target Recognition Using Spectral/Spatial Techniques

OBJECTIVE: Develop target recognition techniques based upon multi-spectral and space-time filtering techniques.

DESCRIPTION: Automatic Target Recognition (ATR) systems are required to minimize aircrew workload and maximize overall

platform/target exchange ratio. Systems with low probability of intercept sensing concepts are most attractive for airborne platform applications. At present Electro-Optical (EO) sensing is the most covert approach available. Existing ATR approaches employing EO sensors have emphasized high spatial resolution, two dimensional wideband sensors with some consideration of low spatial resolution, multi-spectral sensors. The most promising ATR approaches employ target models to predict potential features to be matched against observed features. The recent advent of EO sensors providing a degree of both spatial and spectral resolution has created an opportunity for the development of model-based ATR techniques employing these sensors. This effort will explore the utility of combined spatial and spectral signature information for use in model-based ATR development. Sources are sought to explore the following specific technical areas:

a. Application of multi-spectral/spatial sensing for target recognition: This effort will conduct analysis of existing spatial and spectral EO sensing capabilities to establish potential EO multi-spectral/spatial discrimination features and predictive models of such features. Phase I will concentrate upon identification of promising features with a comparative trade-off between feature potential for recognition and required sensor complexity. Phase II will develop and implement a model-based recognition algorithm, based upon the most promising recognition features from Phase I, in the government supplied Sensor Algorithm Research Expert System (SAREXPERT) model-based algorithm development testbed.

b. Application of space/time filtering approaches to EO sensors for target recognition: Phase I will explore the utility of space/time filter decomposition techniques in EO sensors imagery for estimating target pose (i.e., 3D target aspect relative to the imaging sensor) and extracting features for use in model-based target recognition. Phase II will develop and implement a model-based recognition algorithm, based upon the most promising filtering techniques from Phase I, in the government supplied SAREXPERT model-based algorithm development testbed. Proposals which address the application of the above areas to non-EO sensor data and integration of EO with non-EO sensing will also be considered.

AF91-089 TITLE: Towed Decoy Counter-Countermeasure

OBJECTIVE: Investigate, develop, and evaluate unique and innovative techniques and tactics to protect airborne radars from a Towed Decoy environment.

DESCRIPTION: Towed Decoy is a promising electronic countermeasure (ECM) threat in which an active repeater radiates a signal as strong as the target and therefore guides the weapon away from the actual target. A secondary aspect of Towed Decoy threat is to present the radar with a multiplicity of targets. The premise is that if the defending radars are unable to distinguish between aircraft and decoys, then we must address both threats. New Electronic Counter-countermeasure (ECCM) techniques need to be developed to negate these ECM threats. For our aircraft to survive in a towed decoy environment, advanced technology must be used to reduce the chances of detecting and attacking a false target or decoy. The technique to be developed shall be of such a nature that they are a basic part of the fundamental radar design. Also, these techniques must consider the total electronic warfare environment that the radar will encounter, and not just an isolated Towed Decoy threat. This effort will require access to classified foreign intelligence information; and a facility and personnel clearance level of Secret/NORFORN is required. Under Phase I of the proposed research, the contractor will investigate and define new ECCM techniques that will counter the Towed Decoy ECM threat. At the end of Phase I, the contractor will be required to produce a final report which documents the investigation and definition of these new ECCM techniques, along with a proposal for Phase II. Under Phase II of the proposed research, the contractor will fully develop and evaluate the techniques that showed the greatest potential for success in Phase I. At the conclusion of Phase II, the contractor will produce a final report which documents these techniques, as well as possible future enhancements. Also, a recommended test demonstration approach for the techniques will be presented.

AF91-090 TITLE: Air-to-Air Anti-Radiation Missile (ARM) Electronic Counter-Countermeasure (ECCM)

OBJECTIVE: Investigate, develop, and evaluate unique and innovative techniques and tactics to protect airborne radars from an air-to-air ARM attack.

DESCRIPTION: ARM is an air-to-air electronic countermeasure (ECM) threat that causes a missile to home-in on a radiating radar or aircraft and may increase the vulnerability of the aircraft. This will allow the enemy to possibly reduce the effectiveness of the Air Force aircraft in accomplishing their assigned mission. New ECCM techniques need to be developed to negate these threats. A general requirement is that the ARM ECCM must provide the aircraft emitter with a high probability of survival. The techniques to be developed shall be of such a nature that they are a basic part of the fundamental radar design. Also, these techniques must consider the total electronic warfare environment that the radar will encounter, and not just an isolated ARM threat. These techniques, also, must be generic to all aircraft which need to counter this threat. The ARM ECCM techniques should be effective against any type of ARM guidance. This effort will require access to classified foreign intelligence information;

and a facility and personnel clearance level of Secret/NORFORN is required. Under Phase I of the proposed research, the contractor will investigate, and define new ECCM techniques that will counter the ARM ECM threat. At the end of Phase I, thecontractor will be required to produce a final report which documents the investigation and definition of these new ECCM techniques along with a proposal for Phase II. Under Phase II of the proposed research, the contractor will fully develop and evaluate the techniques that showed the greatest potential for success in Phase I of the project. At the conclusion of Phase II, the contractor will produce a final report which documents these techniques, as well as possible future enhancements. Also, a recommended test demonstration approach for the techniques shall be presented.

AF91-091 TITLE: Reconfigurable, Real-Time, Coherent Radar Simulator

OBJECTIVE: Develop a cost effective, modular, high-fidelity, reconfigurable, real-time simulation of coherent, monopulse threat radars.

DESCRIPTION: A cost effective method of providing high-fidelity, real-time simulation of the full range of modern coherent and monopulse threat radar systems is essential to the efficient development of effective countermeasure techniques and systems. Past hybrid simulators have been designed as clones of individual threat radars to ensure simulation fidelity. This approach limited their availability since it required extensive hardware development for each system and a separate simulator for each threat system of interest. It also gave rise to inaccuracies in the simulation fidelity due to the significant development time needed to update the design to match frequently changing intelligence assessments. The alternative to the hardware implementatation was normally non-real-time digital simulation. This approach, while more responsive to change than the hardware implementations could not normally provide the level of fidelity desired without computation times much slower than real-time. This topic area seeks to exploit the technology opportunities presented by recent developments in high-speed digital processors, parallel processing architectures, fast digitizers and programmable analog devices to develop a truly reconfigurable, real-time, threat radar simulator to perform simulation testing and evaluation. A successful design needs to address all aspects of radar processing functionality: waveform data extraction, angle data extraction and tracking function. Additionally, the design needs to address the real-time performance issues associated with the design. Finally, and perhaps most importantly, the design needs to have a traceability of design parameters to simulation fidelity. Under Phase I of the proposed research, the contractor will develop a preliminary design with an analysis of feasibility and cost/fidelity trade-offs for the various simulation functions. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II. At the completion of Phase I, the contractor will produce a final report which documents the Phase I effort and provides a proposal for the design implementation in Phase II. Under Phase II, the contractor will fabricate, test and document the proposed design. Together with the delivery of the system, the contractor will provide recommendations for further development.

AF91-092 TITLE: High-Temperature Superconducting (HTSC) Switched Delay Line(s) for Active Electronic Warfare (EW)

OBJECTIVE: Develop a low-loss, small-size, wide-bandwidth, HTSC, phase shifter capable of handling high power (2-3 watts) for use in EW active array transmitters

DESCRIPTION: HTSC will enable lighter, smaller, more reliable, systems to be developed with higher operating frequency, wider bandwidth and improved performance. Much work is already being performed towards producing low loss passive microwave components such as delay lines for signals with power levels well under 30 dBm (1 watt). Higher power levels, bandwidths, low microwave loss contacts and switches for delay lines are just now beginning to be considered. Initial results are extremely promising, showing there is no intrinsic property in the HTSC materials preventing power levels and bandwidths to be increased with development, especially in short delay lines needed for high power (2-3 Watt), wide band (6-18 Ghz) phase shifters for EW active array transmitters. Polarization control networks for EW applications currently use 8-bit ferrite phase shifters because of their wide bandwidth and low loss (1-2 dB). But ferrites are large, requiring they be placed before the corporate feed network of the antenna array. It would be desirable to implement the polarimeters in GaAs Monolithic Microwave Integrated Circuit (MMIC) technology and place them directly behind each antenna element of the active array to reduce system size, increase reliability and improve performance. Unfortunately, high resolution GaAs device losses can be as much as 15-16 dB, making them impractical for this application. With development, HTSC will enable practical, high resolution, low dispersion (wide bandwidth) phase shifters which exhibit the low loss of ferrites while maintaining the small size of GaAs MMIC technology. Under Phase I of the proposed effort, the contractor will fabricate a small HTSC delay line designed to optimize its use at liquid nitrogen temperature or above in a compact, high power, low loss, 6-18 Ghz phase shifter. The contractor will then measure the delay line loss versus frequency from 2-20 Ghz at input microwave power levels from 0.01-3 watts (or best capability). At the conclusion of Phase I, the contractor will produce a final report documenting results and conclusions. Under Phase II, the contractor will continue fabricating, optimizing and measuring additional delay lines while introducing low loss, low power

switching. An 8-bit, 360 degree, phase shifter will be a goal for Phase II. Maintaining MMIC size, low loss, power and bandwidth will continue to be emphasized as the program progresses. At the conclusion of Phase II the contractor will produce and deliver a final report documenting results and conclusions along with a multi-bit phase shifter hermetically packaged with input and output connectors.

AF91-093 TITLE: Multi-Threat Engagement Simulator

OBJECTIVE: Develop and implement a real-time, multi-threat electronic combat engagement simulator.

DESCRIPTION: Modern integrated electronic combat systems must handle multiple threats operating in the infrared and visible regions of the spectrum in addition to the traditional radio frequency environments. Furthermore, the growing density and complexity of this multi-spectral environment places increasing demands on the management of electronic combat resources and necessitates the design and testing of new electronic combat resource management systems. Assessment of the operational effectiveness of new systems/concepts requires closed-loop evaluation of how the system under test will perform in a combat scenario at the mission and campaign levels. The objective of this assessment is to determine the electronic countermeasure's effects on the threats. To create an accurate closed-loop simulation that responds to electronic combat techniques will require a detailed weapon system representation. The multi-threat engagement simulator function will close the loop between the electronic warfare system and other simulators (or operate stand-alone) to make the scenario responsive to electronic countermeasures. The multi-threat engagement simulator will be aware of the geometries and modes of all threat systems, will evaluate the effects of generated electronic countermeasures on the threats, will determine responses of the threats to the electronic countermeasures, and will cause other simulators to implement these threat responses when necessary. Under Phase I of the proposed research, the contractor will develop a preliminary design of a real-time, multi-threat engagement simulator which can be operated stand-alone or incorporated into an integrated electronic combat effectiveness evaluation system. At the conclusion of Phase I, the contractor will produce a final report which documents the design of the real-time, multi-threat engagement simulator, and demonstrates the critical aspects of the system. Under Phase II of the proposed research, the contractor will fully develop the real-time, multi-threat engagement simulator. This effort will culminate in a laboratory demonstration which illustrates all salient features of the multi-threat engagement simulator. At the conclusion of Phase II, the contractor will produce a final report which documents the system, as well as possible future enhancements. The contractor will also provide the documented software code that was developed under this effort.

AF91-094 TITLE: Advanced Packaging Concepts and Their Impact on System Design

OBJECTIVE: Investigate the impact on electronic system design considerations related to (1) the concept of failure-free life (FFL) in an all-silicon approach and (2) the use of mixed technology assemblies for ultra-high-speed performance.

DESCRIPTION: With the advances in device technology and integration techniques, namely monolithic, advanced multichip and 3-dimensional packaging, system designers are faced with a new set of design tradeoffs and considerations. Digital processing is moving closer to the analog sensor to meet system-level-communication bandwidth requirements. In addition, systems are being implemented using multichip assemblies, "reliability-without- hermeticity" coatings and enclosures, optical versus wired interconnects, area array interconnect techniques, and liquid/immersion cooling techniques. These approaches will have an enormous impact on design, manufacturability, performance and maintenance and should be considered in the investigation. By using an all silicon approach, the concept of failure-free-life can become a reality. However, when system requirements dictate ultimate performance, mixed technologies will be interconnected on a common substrate to realize the functional requirements. To successfully accomplish both of these approaches, a consistent set of design tradeoffs need to be investigated. During Phase I, trade-off analyses will be performed to assess the impact these two advanced system packaging concepts will have on the overall design. During Phase II demonstration vehicles will be fabricated to analyze and verify the Phase I results.

AF91-095 TITLE: Computer-Aided Electronic System Design

OBJECTIVE: Develop electronic design and synthesis tools.

DESCRIPTION: As clock rates have increased in electronic systems, old methods of system design and packaging are no longer appropriate if maximum performance is to be achieved. Current design and synthesis tools are targeted at single components and largely work at register transfer or logic level descriptions. Thus, designs essentially have to be done before use of the tools. In order to achieve the design of complex electronic functions that cannot be incorporated into a single component, next generation design and synthesis tools must be created that incorporate board and system considerations. Component, board, and system partitioning as well as packaging and test must be considered. The tools should have as an input abstract behavioral and

functional descriptions that include timing and other constraints, based on the ANSI/IEEE standard 1076 hardware description language, and should produce a design that includes packaging and test considerations. Test approaches should include IEEE 1149 and 1029.1 standards. Packaging considerations should include modern approaches such as multi component carriers, integrated backplanes, and direct die on board.Phase I will consist of a six (6) month feasibility study for new and innovative synthesis methods. Concepts and ideas for design partitioning, packaging, and test will be generated. A report documenting these ideas and concepts should be prepared together with designs for a demonstration. Phase II will consist of twenty-four (24) months of additional work to perform the full-scale demonstration of the technique, such that proof of concept can be demonstrated. Phase III will demonstrate full synthesis capability across component boundaries and incorporate packaging considerations as well as test.

AF91-096 TITLE: Sensors for Specific Gases and Gas Concentrations Used in Semiconductor Processing

OBJECTIVE: Develop new and innovative devices and/or techniques for in-situ monitoring of specific gases and gas concentrations in semiconductor processing.

DESCRIPTION: Low-cost, semiconductor-device-fabrication facilities for Air Force, Army and Navy applications are increasingly dependent on real-time process controls for first-pass success in the fabrication of very complex devices in small quantities. The trend in advanced-fabrication facilities for application-specific integrated circuits and special-purpose devices in silicon and other semiconductor materials is moving toward single-wafer processing using all dry plasma processes for deposition, etching, development of resists, etc. As more complex devices and processes are developed, cost-effective, real-time, in-situ sensors become even more critical for process control. In many cases, special sensors are needed to control critical plasma parameters, the rate of the process, or to detect end points accurately. Thin-film-detector technology may be used to monitor critical information and control critical processes in real time. Phase I will consist of a six (6) month feasibility study for new, thin-film detector sensors. New semiconductor processes should be addressed to determine critical process steps limited by sensor availability. Proposed sensor ideas should be theoretically analyzed to determine applicability to these critical process steps and feasibility of the approach. One sensor will be selected for experimental measurement and potential subsequent demonstration. A report of Phase I ideas and activities should be prepared, as well as experiments and designs for a full-scale demonstration. Phase II of this effort will consist of twenty-four (24) months of additional work to perform the full-scale demonstration, depicting limits of performance, operating parameters and benefits of the technique. Phase III will demonstrate equipment implementing this in-situ sensor and process-control technique for use in a semiconductor manufacturing facility.

AF91-097 TITLE: In-Situ Sensors for Molecular Beam Epitaxy

OBJECTIVE: Develop reliable, repeatable and accurate in-situ sensors to monitor and control the growth of a variety of semiconductor materials via Molecular Beam Epitaxy (MBE).

DESCRIPTION: The need for semiconductor heterostructures for advanced device applications makes ever-increasing demands upon growth technologies. In order to meet the demands for precise control of material composition, thickness, and doping levels, new sensors must be developed which permit reliable, repeatable and accurate control information. This information can be applied to automatic monitoring techniques and subsequently to larger-scale production systems. This program is restricted solely to Molecular Beam Epitaxy as a growth technique and will result in hardware demonstrations of innovative techniques. To the maximum extent possible, all proposed techniques must not interfere with normal physical and operational demands of an MBE system. Emphasis will be placed upon those techniques which require only a minimal modification to existing machines. Application of prototype sensors to commercial equipment is desired. Phase I of this program will consist of a six (6) month feasibility study for in-situ sensors for application to commercial MBE systems. New innovative ideas for non-invasive sensors for monitoring composition, thickness and doping densities will be analyzed to determine the feasibility of the approach. Critical experimental results should be obtained to validate the approach. A report incorporating the ideas and experimental verification will be prepared with design concepts for a full scale demonstration. Phase II of this program will consist of a twenty-four (24) month feasibility demonstration of the sensor technology. This feasibility demonstration shall include design, assembly, validation, installation and demonstration of the prototype sensor system in an operational Air Force MBE system. This prototype system is considered a deliverable item under Phase II.

AF91-098 TITLE: Realization of Devices and/or Functions using Optical Illumination of Thin-Film Superconductors

OBJECTIVE: Assess the feasibility of using optical illumination to produce a spatially selective phase transition or impedance variation in superconducting thin-films.

DESCRIPTION: Advanced investigation is required to explore the use of spatially selective optical illumination to define

superconducting device architectures. The phase transition or impedance variation induced by optically illuminating superconductors should be used in the definition of specific device/function architectures. The focus of the effort is to provide an optically definable and reconfigurable device for insertion into USAF radar, communications, and electronic countermeasures systems. The investigation should highlight the benefits derived using this device in place of existing devices or device networks. Emphasis will be placed on the use of the optical interaction phenomena to realize passive devices (e.g. filters, couplers, delay lines, and switches), device networks, and possibly some basic signal-processing functions (e.g. correlation). Material applicationstudies should include bulk and patterned, thin-film, high-temperature, superconducting material studies, but low-temperature and possibly hybrid architectures are encouraged. Typical high-temperature superconducting materials may include compounds based on yttrium, bismuth, and/or thallium. Low-temperature materials may include niobium based compounds. Investigation should include experimentation of the devices at the following temperature regimes; well below the materials critical temperature (Tc), near Tc, at/above Tc. Figures of merit that should be addressed are noise effects, time delay, insertion losses, bandwidth, delay distortion, coupling effects, impulse response, step responses, and phase velocities. Phase I activity should provide proof of concept by assessing material parameters and integrating them with microwave design techniques, and fabrication process and design database development. A study effort alone would not be acceptable. Phase II activities should be a refining of design and fabrication techniques, device fabrication, device testing, characterization, and data base validation.

AF91-099 TITLE: Multiplexing for Fiber-Optic Sensors

OBJECTIVE: Develop optical and electronic multiplexing and demultiplexing techniques for combining multiple fiber-optic interferometric sensors and sensor functions for aircraft instrumentation.

DESCRIPTION: Fiber-optic sensors possess many advantages over their electronic counterparts, which are currently being explored. Many sensors and sensor functions can be multiplexed to maintain situational awareness and redundancy while minimizing the number of components. Fiber-optic interferometric and other types of fiber-optic sensors have been used to measure temperature, pressure, strain, acoustic pressure, rotation, acceleration, E/M fields and other phenomena. This program would develop techniques which show promise for the implementation of a fiber-optic sensor "nervous system" which may be used in advanced aircraft, smart-structures/skins applications. The sensors would be arranged in passive element arrays and selectively perform different sensing functions. Phase II would enable the deconvolving of each of these data inputs from a single sensor and sensor array.

AF91-100 TITLE: Low-Insertion-Loss Millimeter-Wave Probes for On-Wafer, Noise-Parameter, Measurement Accuracy

OBJECTIVE: Develop low-insertion loss, high-frequency, wafer probes with improved noise-parameter accuracy in transistor and integrated circuit characterization.

DESCRIPTION: The development emphasis in frequency extension of wafer probes for on-wafer noise/scattering-parameter measurements of MMICs has overshadowed the critical need for low-insertion loss, millimeter-wave wafer probes for accurate noise characterization of extremely low-noise devices, such as high electron mobility transistors. Noise-parameter measurement accuracy is a function of instrument uncertainty, the number and location of source- reflection-coefficient states, and the parameters of the device under test. Probe losses increase the possibility of the device's optimum source impedance falling outside the matching area of the tuner, as well as increase the second-stage noise figure of the measurement system. These factors can result in large measurement errors when characterizing low-noise devices. Low-loss probes will improve the measurement accuracy of on-wafer noise-parameter measurements and result in more accurate device/MMIC characterizations and designs. The developed probes must have the capability of easy integration with commercially available probe stations for on-wafer noise/scattering- parameter measurements. Phase I of this program will consist of a six (6) month feasibility study for the low-insertion loss, millimeter-wave, wafer probes. A report documenting ideas, design, analysis, and experimental measurements should be provided. Phase II of this program will consist of an additional twenty-four (24) months of work to complete development of the wafer probe and integration into commercially available, on-wafer, scattering/noise-parameter test systems, such that performance can be analyzed.

AF91-101 TITLE: Optical Sensor Development for Fluid-Flow Measurement

OBJECTIVE: Develop new, optical, non-intrusive methods for critical measurements in areas of complex flow interactions.

DESCRIPTION: Optical, non-intrusive diagnostic techniques such as laser velocimetry, inteferometry, holographic cameras and laser-light sheet systems are used extensively in fluid dynamic test facilities to provide non-perturbing parameters. Advancement in electro-optics technology in recent years may significantly expand the capability of such instrumentation. For example, fiber optics

and/or holographic optical elements, when integrated with existing measurement technology, may provide the required optical access into boundary layers at structure junction points, and even into internal flow channels. Another example can be found in the recently developed TV holography that may allow for much broader application of holography in wind tunnel diagnostics, for the study of model parameters. Phase I activity will include concept development and a feasibility study through a consideration of optical interference, facility and/or model vibration, temperature fluctuation, etc. Phase II activities will lead to the development and fabrication of a system including validation using a calibrated measurement. Consideration must also be given to application to full-scale flight vehicles.

AF91-102 TITLE: In-Place Data Recorder for A...raft Transparency Systems

OBJECTIVE: Develop a device that is attached to an aircraft transparency system which will record fabrication history and operational experience.

DESCRIPTION: One of the largest challenges confronting designers of windshield, canopy, and window systems of Air Force aircraft is obtaining realistic, actual, and complete data on the fabrication history and operational experience of existing transparency systems. Available data is scattered among many sources and, when acquired and interpreted, has proven to be incomplete for use in failure analysis methods, reliability prediction methods, and durability specification development. Phase I activity will involve analysis and application of results from review of related technologies which include smart skins; programmable, erasable, read-only, memory devices; data sensors; miniaturized electronics aircraft data recorders; and field operated computers. Possibilities for tie-in with the aircraft main data base and/or power source, and for data load and data dump by the crew chief will also be examined. Phase II activity will involve the design, fabrication, and demonstration of an in-place, data acquisition, recording, and retrieval system for full-scale, aircraft, transparent structures.

AF91-103 TITLE: High-Gain, Acoustic, Sensor System for Aircraft Noise Signature Detection

OBJECTIVE: Develop a high-gain, acoustic, sensor system which will result in an order-of-magnitude increase in the signed-to-noise ratio of aircraft noise signatures.

DESCRIPTION: One method to detect low flying aircraft is by their radiated acoustic signature. The suppression of the radiated acoustic signature requires that a higher signal-to-noise ratio be realized at the point of reception if the same detection distance is desired. This requirement illustrates the need for a high-gain acoustic sensor which will result in at least an order-of-magnitude increase in the signal-to-noise ratio of aircraft noise signatures. Unique and novel sensors and sensor configuration need to be designed to achieve this objective. Phase I activity will include a feasibility study to determine the technical feasibility of the proposed effort. If it is shown to be feasible, the end product of Phase I will be the recommendation of a specific design of a high-gain acoustic sensor system. Phase II will include a laboratory or field test to verify the performance of the sensor system recommended in Phase I.

AF91-104 TITLE: Application of Unique Motion Devices for Control of Primary Flight Actuators

OBJECTIVE: Investigate the use of novel controlled-motion devices capable of main-control-valve operation for primary flight-control actuator.

DESCRIPTION: As military aircraft become more agile and powerful, the flight control actuation devices become more complex and heavier. Electrohydraulic valves (EHVs) are currently used to control the main control valve, which in turn controls the flight-control actuator. The EHV and corresponding hardware are the key drivers to system complexity and weight. Unique motion devices are sought that will perform in the same manner as an EHV but with less complexity and weight. For example, field dependent fluids and piezoelectric crystals have been investigated for EHV control capabilities. This effort will entail the design, development, and test of a prototype device capable of operating the main control valve for a primary flight control actuator. Phase I activity will entail design studies to determine concept feasibility in association with predetermined power requirements, control limitations, and operation parameters. It will also identify a final design for development and test. Phase II will proceed with hardware development and proof-of-concept tests. A Phase III follow-on effort may examine optimization of the motion device as a primary surface actuator and eliminate the main control valve.

AF91-105 TITLE: Projectile-Target Impact History Sensor

OBJECTIVE: Development of a 3-axis force sensing and recording or transmitting device for installation in a 23mm diameter projectile to impact composites at 1500 feet per second.

DESCRIPTION: Ballistically ignited fuel fires represent the most frequent cause of aircraft losses. Current incendiary projectiles are designed to operate against metallic targets although composite structures are replacing these in military aircraft. Vulnerability assessment must address the interaction force history during penetration of composite panels to understand, explain, and predict the penetration mechanics and projectile incendiary functioning. A recording and transmitting interaction force sensor would prove invaluable in experimental investigations designed to understand, develop, and verify theoretical predictions for threat phenomena. Progress in microelectronics and integrated sensors has made such a device possible. Phase I will be to develop a prototype sensor capable of being mounted in an inert 23mm projectile which will either transmit or record acceleration during impact. Phase II would be a calibrated and verified sensor capable of being used in any projectile, 23mm or larger.

AF91-106 TITLE: Numerical Analysis on Massively Parallel Processing Computers

OBJECTIVE: Establish procedures for running Navier-Stokes or Euler formulated fluid dynamics codes on single-instruction-multiple-data (SIMD) or multiple-instruction, multiple-data (MIMD) parallel computers.

DESCRIPTION: Numerical analysis of fluid flows about arbitrary shapes requires the volume surrounding the shape to be decomposed into a discrete grid or mesh. For moderately complex geometric shapes, these grids may contain millions of points. On each of these discrete points, the computational fluid dynamic (CFD) code solves for primitive fluid variables, such as density, velocity, and temperature. During this process, the CFD code stores and uses from 25-85 words per grid point. Execution of the codes, therefore, requires many millions of words of storage, and consumes many hours of computer time. Phase I of the effort will determine if a massively parallel computer architecture can be used to significantly speed up the numerical solution of the Reynolds-averaged Navier-Stokes and Euler equations. The contractor will discuss the relative merits of SIMD and MIMD architectures and, if appropriate, other architectures that would be advantageous for CFD solutions. The contractor will also discuss the optimum number and/or arrangement of processors and compare maximum theoretical computer speeds with realistic speeds for practical problems. A possible Phase II effort would be to develop or modify a Reynolds-averaged Navier-Stokes or Euler code that would be optimized to run on an existing machine that utilizes the computer architecture determined in Phase I to show the greatest payoff.

AF91-107 TITLE: Determination of the Mechanical Response of Microscale Structures

OBJECTIVE: Develop methods and associated equipment to measure the mechanical behavior of the microscale structures that make up today's electronic equipment.

DESCRIPTION: As the size of electronic assemblies shrinks, it becomes more difficult to measure the responses of the microscale structural elements (i.e., component leads, solder pillars, conducting traces, etc.) to stress inducing effects. Electronic assemblies are highly loaded, are non-linear in response, and exhibit time-dependent deformations. Knowledge of these responses is necessary to allow durability assessments of modern avionics to be accomplished during the early stages of design. Advanced methods, including innovative instrumentation and experimental apparatuses, are needed to enable the mechanical behavior of these microscale structures to be determined. These techniques should also be applicable to larger scale systems. Phase I must demonstrate understanding of the scope and complexity of the problem. It must provide detailed engineering analysis and design specifications for the proposed methods. It must also include a test procedures plan for validating the performance of the method. Phase II requires construction and validation of a prototype as described in the plans of Phase I. Correlation of results with other established techniques will be required.

AF91-108 TITLE: Turbulence Modeling

OBJECTIVE: Develop a generalized turbulence model method for use in computational fluid dynamics (CFD).

DESCRIPTION: Identify deficiencies in current turbulence models, develop improved turbulence models and incorporate improvements in one module to handle a variety of flow effects. Many studies have been done to modify turbulence models for various effects: low reynolds number, surface roughness, strong pressure gradients, and merging of shear layers. The inclusion of these effects in a single module for utilization in state-of-the-art multizone Navier-Stokes codes would be helpful. Such an effort would assess the success of the above modifications and would point out other deficiencies in current turbulence models as well as provide logic so that the proper coefficients and scales are used in each case. Simple "prior history" effects may also be included as long as code efficiency does not suffer significantly. Phase I of this research effort will be the identification of all turbulence modeling schemes available for fluid mechanic flows with a complete description of the physics embodied in each approach. Phase II will be experimental validations of CFD solutions incorporating the recommended turbulence models. These satisfactorily validated turbulence modeling methods will then be programmed into a single module that could be retrieved for CFD solutions.

AF91-109 TITLE: Cockpit Design for Super-Maneuverable Fighter

OBJECTIVE: Identify cockpit design criteria for super-maneuverable fighters that permit full exploitation of system capabilities.

DESCRIPTION: The capability now exists for significantly enhancing the maneuver capability of fighter aircraft. By operating in the low-speed, low-G arena, Air Force fighters will possess an advantage over adversary aircraft with the potential for greatly improving the Close-in-Combat kill ratio. Full exploitation of this capability, however, requires that the pilot be fully aware of the combat situation and be able to intuitively employ the total maneuvering envelope. The problem is such that information display requirements and pilot control techniques for fully exploiting the potential tactical advantage of super-maneuverable fighters are undefined. Phase I work will identify specific applications of super-maneuverability through mission analysis and identify unique control and display criteria and pilot constraints associated with its implementation. Based on these requirements, cockpit designconcepts will be identified. Particular areas to be emphasized in the designs include use of automation, situation awareness, pilot decision-aiding, and two-ship coordinated attack. Upon completion of the Phase I effort, the various options that have been considered will be rated in terms of scientific or technical merit and feasibility, and best ideas for design will be chosen for further pursuit in Phase II. The Phase II approach will be to investigate the most promising Phase I concepts under full combat simulation. The goal of the Phase II effort will be to produce a well defined cockpit design. Products of the Phase II effort include software and cockpit graphic displays as well as a final report defining areas for application.

AF91-110 TITLE: Rapid Flight-Line Detection of Degraded Electronic Cockpit Instruments

OBJECTIVE: Develop a rapid, "go-no-go" test method/equipment providing flight-line assessment of legibility performance of CRT and matrix type cockpit displays.

DESCRIPTION: There is a new generation of cockpit instruments which are totally electronic and embody none of the gears, levers, motors and painted read-outs of the old generation instruments. From a military viewpoint these new instruments bring with them several significant advantages. However, they also bring with them a radically new, high-technology identity that must be dealt with logistically, especially on the flight line. Transitioning these instruments from the laboratory to field use requires a unique/testing method for checking against degradation. The new generation instruments will be capable of electronically displaying high resolution sensor video information and alphanumeric/symbolic images to the pilot that heretofore have not been possible. Pictorial rather than word descriptors will enable the pilot to more accurately and rapidly assimilate the status of conditions relating to the control of his flight vehicle and associated tactical activities. Producing electronic instruments with such capabilities is within our grasp today. Day-to-day checks for degradation of this imaging capability, in a practical manner under tactical operational conditions, is not within our grasp today. The science of electro-optics is the knowledge base for this new display instrument. The image quality produced by these new instruments is dependent upon the interactive behavior of optics-related parameters such as: luminance, spot-size, gray scale, color, contrast, uniformities, and resolution. Subjective assessments by the pilots and field maintenance personnel will not be sufficient. The original specification performance values (or their analytical equivalents) will have to be periodically measured in the aircraft for meaningful signs of degradation. The measurement of these parameters is presently accomplished by the use of precision laboratory-type instruments. To merely repackage and ruggedize such instruments for flight-line use is not the answer. The time-consuming and highly skilled procedures involved in these tests would be prohibitive in an operational environment. In Phase I a flight-line image-quality assessment test will be developed that replaces the specialized skills and impractical, cumbersome laboratory-equipment approach; and basic demonstrations will be provided that validate the developed test. During Phase II a model of the related equipment will be developed and fabricated; and a data base accumulated and verified to support its transition to a potential Phase III prototype, operational evaluation. Special test patterns can be provided on the electronic display instruments, if required, to accommodate the new test.

AF91-111 TITLE: Real-Time, High-Density, Spatial-Light Modulator

OBJECTIVE: Develop a Spatial Light Modulator capable of real-time, high-density modulation of transmissive or reflective illumination for information display in cockpits.

DESCRIPTION: Future cockpits require high-definition, real-time displays which are light-weight and space-efficient. A promising method of meeting these requirements is to spatially modulate a light source with a 2-D array of viable transmissive or reflective pixels. In addition, the spatial modulation of light is becoming a required characteristic of many other applications, including projection displays, coherent optical processing, spatial filtering, optical computing and computer generated holography. The performance of any of these applications is generally related to the speed and resolution of the modulating device. A useful step in the evolution of such modulators will be the development of a device with a maximum 10 millisecond response (for 1,000,000 addressed pixels), 100:1 minimum contrast ratio and pixel density of at least 40,000 pixels per square centimeter. As

these devices are generally intended as components for integrated system, space requirements and cost should be minimized. Phase I will involve the demonstration of a multipixel device (at a rate commensurate with the above response time) and the presentation of scaleability, fabrication and cost issues associated with the device. Phase II will involve the characterization, optimization, fabrication and demonstration of a 1,000 x 1,000 pixel (minimum) device.

AF91-112 TITLE: New High-Performance Polymers

OBJECTIVE: Investigate the synthesis, processing, and properties of new high performance polymer systems.

DESCRIPTION: Investigations are sought to discover new polymeric materials with potential for the development of improved structural materials. Polymer systems with exceptionally high use temperatures and reasonably low processing requirements are of primary interest. Areas of emphasis include investigations of the following: (a) synthesis routes and methods to improve processing of rigid-rod polymer molecular composites which give rise to very thermally stable (600o to 700oF use temperatures) structural materials under reasonable processing conditions and without the evolution of impractical quantities of volatiles; (b) thedevelopment of a new generation of high strength rigid-rod polymer molecular composite liquid shim materials for low cost high structural integrity air frame assembly; (c) theoretical and synthetic chemistry to provide fundamental understanding of the molecular requirements for achieving nonlinear optical or intrinsically conductive properties in organic and semiorganic polymer systems; (d) processing, morphology and mechanics of rigid-rod polymers to discover approaches for achieving superior compressive strengths; and (e) polymer structure-property correlations to elucidate processing options for achieving desired morphologies as well as electro-optical and mechanical properties. The establishment of viable approaches to obtaining improved nonmetallic materials are sought in Phase I efforts which can be pursued in Phase II follow-on efforts to further develop the new high performance polymers.

AF91-113 TITLE: Smart Processing of Carbon-Carbon Structures

OBJECTIVE: Develop reliable and reproducible structures through smart processing, process control, and defining microstructure/property relationships.

DESCRIPTION: Advanced innovative approaches are needed for the development and implementation of reliable and reproducible carbon-carbon composites for turbine engine, hot structure and space applications. In order to accomplish this, structure/microstructure/property relationships for substrates and coatings must be defined, advanced high-temperature sensors and in-process control methodologies must be developed and life prediction must be addressed. Smart processing approaches for the development of microstructure/structure vs property relationships through the use of advanced sensors and process control methodology will be investigated. Phase I will address the processing schemes, sensors and/or control methodology necessary for substrates and coatings which provide improved intrinsic materials structure and microstructure which can be used in future Air Force Systems (turbine engine, hot structure and space applications). Phase II will perform the enhancements of the developed materials, sensors or control methodology in order to promote rapid development of smart processing of carbon-carbon structures.

AF91-114 TITLE: Controlled Emissivity Materials and Techniques

OBJECTIVE: Develop new and improved materials and techniques for controlling the emissivity of surfaces.

DESCRIPTION: The Air Force is interested in conducting research into the science of understanding and controlling the emissive/reflective nature of materials. Specifically, research shall involve controlling emissivity/reflectivity in the ultraviolet, visible, and infrared regions of the electro-magnetic spectrum. Investigations may include bulk materials, properties and/or novel concepts based on combinations of constituents materials in some unique construction. Phase I of this effort will address application requirements and goals as well as initial formulation, fabrication and evaluation of specific subjects for proof of concept. Phase II will further develop and optimize the material(s) techniques, and produce larger samples for a full spectrum of evaluations.

AF91-115 TITLE: High-Temperature Structural Materials for Advanced Air Force Systems

OBJECTIVE: Develop and characterize advanced, high-temperature, structural materials and model forming processes.

DESCRIPTION: New approaches are requested to develop and characterize advanced, high-temperature, structural ceramic composites (2500o to 4000oF, excluding carbon-carbon composites) and inter-metallic materials and composites (2000o to 3000oF, excluding titanium aluminides), and to model forming processes for advanced structural materials. For ceramic composites, research may include new, unique, continuous, ceramic reinforcement/ceramic matrix systems and coatings; reinforcement/matrix

interactions during processing for use; continuous fiber development; test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain, etc) as a function of temperature and loading history; and, analytical modeling of composite behavior. For intermetallic materials and composites, research may include new or novel methods for synthesis of intermetallic materials with emphasis on achieving theoretical density, low defect content, and low synthesis temperatures; methods for identifying, synthesizing, characterizing, and modeling intermetallic composites; and methods of fabricating composites to provide chemistry control on a sub-micron scale while maintaining the ability to vary and control the final microstructural scale. For modeling of forming processes, research may include modeling of the unit forming process; modeling of the material behavior in response to the demands of the unit process; modeling of the interface between the work piece and the die or mold; and novel methods for obtaining physical property data and constitutive equations for insertion into the models. Phase I will focus on the critical issues which when solved will provide proof of concept. Phase II will be structured to develop and refine those feasible concepts to the point where an assessment could be made of ultimate potential to help meet Air Force advanced materials needs.

AF91-116 TITLE: Improved Nondestructive Evaluation

OBJECTIVE: Development of new, nondestructive, evaluation techniques for advanced aerospace applications.

DESCRIPTION: Advanced, innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection, imaging and characterization of flaws and other integrity-reducing anomolies in flight vehicle and engine materials including metals, and metal and non-metal matrix composites. Improved techniques are also needed for real-time monitoring of the manufacturing processes used to fabricate aerospace components from these materials. In particular, innovative technical approaches are needed for (a) the detection, imaging and characterization of bulk and surface anomolies in both metallic and nonmetallic structures; (b) the evaluation of the integrity of bondlines in structures containing adhesive and metal-metal bonds; (c) the determination of the condition of matrix and reinforcing substructures in advanced composite structures; (d) establishing the quality of high-temperature material coatings; (e) the inspection and evaluation of electronic device materials and components; and (f) the quantitative characterization of materials properties. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and field inspections or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the clear potential for ultimate use in realistic manufacturing or in-service environments. Phase I of this program would address the initial formulation, fabrication, and evaluation of specific NDE techniques for demonstration of proof of concept. Phase II will perform enhanced development for optimization of the techniques investigated in Phase I.

AF91-117 TITLE: High-Performance Light Metal Alloys and Metal Matrix Composites

OBJECTIVE: Develop improved light metal alloys and composites based on the aluminum, beryllium, titanium, and magnesium systems.

DESCRIPTION: Unique approaches which result in new aluminum, beryllium, magnesium, and titanium alloys are required to support the technology/system requirements identified in the Air Force Systems Command Forecast II Study. Incorporated are ultra high temperature aluminum alloys to replace titanium for applications up to 900oF, and ultra high temperature titanium alloys to replace superalloy for applications up to 1800oF. Environmentally stable, ultralight magnesium and beryllium alloys are also desired. Included is the response of all alloys to secondary processing. Titanium alloy requirements specifically address three areas: temperature stability up to 1800oF, strength up to 210 ksi, and high modulus/density ratio. Improvements in strength, stiffness, and a reduction in density may be possible using novel alloying additions. Metal matrix composites (MMC) offer considerable promise for aerospace applications because of their strength-to-density ratio and potential use at high temperatures. Low cost scaleable approaches are needed for fiber wetting, composite compaction and assembly. Matrix materials considered should take advantage of unique property improvements available through rapid solidification technology (RST). Research is now needed to explore property improvements and corrosion resistance especially in composite systems based on Mg alloys. Phase I of the program must address application requirements and goals as well as evaluation of specific properties. Phase II will optimize chemistry and processing and also produce larger amounts of material for a full spectrum of mechanical property evaluation. It will also include preliminary evaluation of trade and design studies to give an early indication of future application potential.

AF91-118 TITLE: Advanced Semiconducting Materials

OBJECTIVE: Develop advanced semiconducting materials and improved processes for epitaxial growth of these materials.

DESCRIPTION: Advanced Air Force electronics, radar, control and communication systems will require new and novel semiconducting materials to meet challenging frequency, speed and temperature requirements. Conventional semiconductors such as silicon and gallium arsenide cannot meet these requirements. Material systems of interest include (a) high temperature semiconductors, such as silicon carbide and single crystal diamond for specialized applications, (b) innovative Group IV and III-V heterostructures superlattices, and (c) wide band gap II-IV and II-VI heterostructures for electronic applications. The heterostructures and superlattices (artificially structured materials) require thin-film epitaxial growth techniques. A goal of this task is the development of improved growth techniques that will result in higher quality films with higher yield and output. Innovative improvements in growth techniques such as molecular beam epitaxy; metal-organic chemical vapor deposition; and laser deposition are sought as well as new techniques. In parallel with these efforts, advanced in-situ, process monitoring techniques are sought which can be coupled with an expert system to provide automated process control for growth of these ultra-precise epitaxial films. Another goal is investigation of high temperature semiconductors. Process modeling of growth techniques is within the scope of this task. Phase I will address process development and initial testing to show proof of concept. Studies and/or design without actual testing are not appropriate for Phase I. Phase II will optimize the process to show potential for commercialization.

AF91-119 TITLE: Nonlinear Optical Materials

OBJECTIVE: Develop nonlinear optical materials with properties superior to those presently available.

DESCRIPTION: Nonlinear optical materials are required for a variety of potential Air Force applications including optical signal processing (switches, modulators, and guided wave devices) and new laser sources (optical parametric oscillators and harmonic generators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts must address material issues for inorganic and organic materials in either bulk or thin-film forms. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only for the purpose of evaluating and demonstrating the properties of the material(s) developed. Phase I of this program would demonstrate the proposed growth or processing techniques. Phase II would perform optimization of those techniques.

AF91-120 TITLE: High-Temperature Superconducting Materials

OBJECTIVE: Develop high-temperature, superconducting, thin-film materials for sensing and modifying electromagnetic radiation.

DESCRIPTION: High-temperature superconducting (HTS) materials offer a variety of application opportunities. Detection of infrared (IR) radiation can potentially be improved through the use of these HTS materials. For example, sensitivity, operating temperature, and signal processing speed are functions that need to be increased over present technology. The properties of the materials must be established and detection techniques evaluated (e.g. bolometers and Josephson Junctions) in order to fully assess their value in electromagnetic sensing. Modeling of the superconducting mechanisms, development of unique thin-film deposition, processing methods which produce films with the required properties, opto-electronic response and temperature-dependent noise measurements are examples of topics considered appropriate for this program area. This topic addresses development of thin-film fabrication techniques and characterization of the opto-electronic response of these films. Device development will not be supported. Phase I will address application requirements and goals as well as initial formulation, fabrication, and evaluation of specific subjects for proof of concept. Phase II will perform enhanced development for optimization.

AF91-121 TITLE: Characterization of Latent Defects in Avionic Hardware

OBJECTIVE: Develop techniques for characterizing latent defects in avionic hardware.

DESCRIPTION: Technology advances are required in electronic failure analysis and material characterization in order to develop reasonable, failure-free, operating periods for avionic equipment. The level of reliability achieved by most deployed avionics is significantly less than desired by the user, producer, and developer. Additionally, avionics is becoming the driving force for flight safety. Identifying and characterizing latent defects in electronic assemblies and components is of primary interest. Technology areas of specific interest include printed wiring boards, integrated circuits, and hybrid microcircuits. A Phase I effort should determine the feasibility of identifying a manageable number of defects which are associated with one or more of the identified technology areas. Rationale for selecting a given defect should be discussed. Materials behavior and failure analysis experience should be used to discuss how the identified defects can result in hardware failures. A Phase II effort would design and conduct experiments for evaluating latent defects and determining their life-limiting characteristics. The environmental conditions necessary

to stimulate the failure mechanism associated with the defect would also be evaluated. Methods of reducing the occurrence of given defects and minimizing their effects is the overall goal.

AF91-122 TITLE: Non-Chromated Corrosion Inhibitors for Adhesive Bonding and Painting Processes

OBJECTIVE: Develop non-toxic corrosion inhibiting additives for paint and adhesive bond primers for aluminum substrates.

DESCRIPTION: Organic and inorganic (non-toxic) (non-chromate) materials will be evaluated for use in paint and adhesive bond primers for use on aluminum. Metal organic complexes, quanidienes and quaternary chelatin agents and combinations of these materials will be evaluated and compared to the existing chromium containing materials for corrosion resistance effectiveness. This work is vital to the Air Force Logistics Command program to eliminate toxic materials from production applications. Phase I objectives will be to demonstrate the feasibility of the use of corrosion-inhibiting additive packages, either organic, inorganic, or both, to replace existing chromates. Phase II objectives will be to optimize corrosion packages specifically for bonding and painting applications and to do testing and evaluation so that specifications may be written to allow the use of these materials in military applictions.

AF91-123 TITLE: Resin Transfer Molding of Thick High-Density Preforms

OBJECTIVE: Demonstrate the feasibility of low-cost, high-performance, structural components for aircraft.

DESCRIPTION: High rate, low cost, production processes, including resin injection molding (RIM) and resin transfer molding (RTM) will be modified as necessary and evaluated for feasibility of their use in the production of high performance, aerospace, composite materials. Epoxy and bismaleimide (BMI) resins shall be utilized in combination with graphite reinforcements in the form of thick (1/4 to 1/2 inches) high-density (20 percent volume remaining) preforms to fabricate laminates for test and evaluation. The development of low-cost fabrication processes for high-performance composites is of paramount importance in the economical use of composites in aerospace structures. Phase I objectives are to develop and demonstrate injection processes for resin transfer modeling of thick, high density, carbon fibers, filament wound preforms. Phase II objectives will be to scale up and optimize the resin injection process to achieve lower costs consistent with aerospace quality and to generate sufficient data to allow materials and process specifications to be written.

AF91-124 TITLE: Cellular Automata for Molecular/Atomic Modeling and Simulation

OBJECTIVE: Develop new approaches to physical modeling of material processes.

DESCRIPTION: Cellular automata are the computer scientist's counterpart to the physicist's concept of "field". They provide natural models for many investigations in physics, combinatorial mathematics, and computer science that deal with systems extended in space and evolving in time according to local laws. A cellular automata machine is a computer optimized for the simulation of cellular automata. Its dedicated architecture allows it to run thousands of times faster than a general-purpose computer of comparable cost programmed to do the same task. These machines are continuing to improve in terms of price and performance to enable efficient physical modeling and simulation of various material processes where control of molecular/atomic bonding is critical. Phase I should address the feasibility in terms of needed development (hardware and software) to enable the modeling of such processes as Molecular Beam Epitaxy and Metal Oxide Chemical Vapor Deposition for diamond growth and various electro-optical materials. Phase II will involve the development of a state-of-the-art cellular automata machine to support material design, process planning and control for selected materials.

AF91-125 TITLE: Innovative Metal Matrix Composites Processing

OBJECTIVE: Investigate the development of innovative methods of processing for metal matrix composites.

DESCRIPTION: Investigations are sought to develop innovative processing schemes for continuous fiber, reinforced, metal matrix composites. Principal emphasis is to be placed on aerospace quality materials such as near alpha and beta titanium alloys, and alpha-2 and gamma titanium aluminide intermetallic compounds reinforced with continuous fibers of silicon carbide, alumina, or other appropriate materials. Current processes make use of hot isostatic pressing and, less often, vacuum hot pressing to consolidate alternating layers of foil and fiber, metalized fiber, or multiple layers of reinforced monotapes to produce an intermediate product form. Problems with this approach include high cost of equipment and products, low yield, and potential damage to reinforcing fibers. The establishment of alternate viable approaches to obtaining fully consolidated high-quality titanium or titanium aluminide, metal matrix composites are sought in a Phase I program. Phase II follow-on efforts will demonstrate the effectiveness of alternate approaches to metal matrix composites consolidation identified in Phase I.

AF91-126 TITLE: Concurrent Engineering

OBJECTIVE: Develop concurrent engineering methodology for the design of electronic products and processes and the product life-cycle.

DESCRIPTION: Concurrent Engineering is the integrated design of the product, manufacturing, and support processes with emphasis on efficiency, improved quality, and reduced cost. The method developed needs to allow for the interaction of constraints from the various disciplines and employ algorithms for resolving conflicts. The information available from the various experts in each discipline is intended to be unified during the design phase. The Air Force has particular interest in improving the product life-cycle of multi- layer interconnect structures used in advanced electronic systems. Three areas of particular interest include: (a) Use concurrent engineering techniques to interactively trade-off system parameters (e.g., performance, cost, reliability, etc), technical parameters (e.g., electrical, mechanical, thermal, chemical properties), materials, and processes; (b) Define an information architecture that includes a product description framework to facilitate interactive communication between experts in each discipline; (c) Identify/develop applicable design and decision support tools to facilitate integration. Phase I will address application requirements and goals for proof of concept. This includes identifying attributes to describe the function, size, and behavior of components needed in electronic design. Phase II will develop and demonstrate a candidate concurrent-engineering methodology applied to electronic product design. Phase II will establish the information storage-and-retrieval mechanisms for modeling the behavior of complex interconnect structures needed for the design.

AF91-127 TITLE: Ultra-High-Purity Starting Materials for Infrared (IR) Detector Crystal Growth

OBJECTIVE: Reduce of trace impurities in IR detector materials

DESCRIPTION: There is a critical need for the reduction of trace impurities in elemental and intermediate compound materials used in the manufacture of HgCdTe infrared detectors and focal plane arrays, since these impurities severely limit both performance and yield. Other applications of II-VI compounds are equally demanding of high purity. The elements of Cd, Zn, Se and Te and intermediate compounds CdTe, ZnTe, and CdSe are of major interest, as are all impurities which affect the electronic or crystal growth properties of both bulk and epitaxial crystals. This project will investigate the development of advanced distillation, zone refining and sublimation techniques to yield ultrahigh purity grades of the required starting materials. Integral to the project will be the establishment of measurement methods to prove that purity enhancements have been achieved. These might be either direct or indirect methods sensitive down to the 10 to 20 ppba level with respect to impurities. In Phase I, the purification and characterization techniques will be developed and confirmed. In Phase II, the process will be scaled up to commercial production levels, and the enhancements with respect to detector performance will be quantified.

AF91-128 TITLE: Computer Graphics for Bearing Dynamic Analysis

OBJECTIVE: Develop computer software for animating the dynamic behavior of rolling element bearings.

DESCRIPTION: Bearing dynamic computer codes are used by the aerospace industry to design and analyze high-precision rolling-element bearings such as those found in gas turbine engines. The numerical output of these computer codes consists of the three-dimensional displacement of the rolling elements and bearing cage. To visualize the bearing interaction, two dimensional plots are generated which depict the displacement, velocity, and acceleration of each bearing element in one direction. The designer/analyzer must then take these composite plots and construct a mental image of the interactions to visualize the three-dimensional dynamic behavior. A much more efficient means of designing and analyzing rolling element bearings would be to take the numerical output from the bearing dynamic code and input this to computer animation software which would show the interaction of the bearing elements occurring simultaneously. By viewing the bearing from different visual perspectives, a true three-dimensional description of the bearing-dynamic behavior could be easily translated to the designer/analyzer. It is envisioned the computer software for the animation could be developed for use on today's high-speed personal computers. A goal for Phase I of this program would be to demonstrate an animated pictorial of an operational bearing from the axial perspective. This should be accomplished by using the numerical output from an existing, bearing-dynamic, computer code as input to the computer animation software. Phase II would further develop the animation software to include different views of the bearing, as well as thermal and stress contours of the mating and interacting surfaces. As proof of concept, a bearing for an advanced gas turbine engine application should be thoroughly analyzed and documented. The Phase III potential for this effort would be to market the computer software to the aerospace industry as well as other private companies involved in high-precision bearing design and analysis.

AF91-129 TITLE: Jet-Fuel Thermal-Stability-Improving Additives

OBJECTIVE: Develop additives to improve the thermal capability of jet fuel, Grade JP-8, by 100oF.

DESCRIPTION: Aircraft heat loads are growing at a rapid pace. Aviation turbine fuels are increasingly being used as a heat sink for the heat loads from the aircraft subsystems. New fuels with improved high-temperature stability are required. Fuel additives have the potential of increasing the thermal stability of existing fuels such as JP-8. Phase I of this research and development activity involves the identification and testing of additives that offer the most promise for increasing the high temperature stability of JP-8 jet fuel by 1000F. Phase II research would consist of the selection of the most effective additive(s) for improving thermal stability, development of methods to test additive effectiveness, and determination of thermal- degradation-reaction mechanisms. In Phase III, the most effective additive for improving jet fuel thermal stability will be selected. Testing criteria for use in jet fuel will be established in conjunction with the Air Force jet fuel specification authority. Qualification testing will then be accomplished on the selected additive.

AF91-130 TITLE: Methodology and Software for Turbine Engine Lubrication Sensitivity Analysis

OBJECTIVE: Develop sensitivity study methodology to assess impact of lubrication systems on turbine engine performance.

DESCRIPTION: For turbine engine design purposes, methods have been developed to assess the impact i.e., sensitivities of compressor flows, efficiencies, etc. on projected engine performance. Such methods typically employ iterative computer algorithms to calculate the sensitivities. The cycle decks are typically restricted to basic performance parameters with, perhaps, some capability to determine the effect of parametric changes on projected missions. Cycle decks are not available to assess impact of performance of new lubricants and lubricant system designs using software codes for personal computer implementation. Development of these critical methodologies and software are required to perform sensitivity analyses so that Integrated High Performance Turbine Engine Technology design goals might be efficiently met. Phase I activities will include assessment of the concept, gathering of pertinent data on lubrication systems performance projected for advanced turbine engine designs, assessment of projected mission profiles and selection of algorithms, software and hardware required to implement the system for sensitivity studies. Phase II activities will include development of the methodology and software sufficient to perform such sensitivity studies using a personal computer. Demonstration and delivery of the software will be required. This effort has Phase III potential to develop software designed for lubrication-systems sensitivity analysis by turbine-engine engineers, aircraft designers, and lubricant and lubrication system component vendors.

AF91-131 TITLE: High-Speed Turboramjet Technologies

OBJECTIVE: Develop key technologies for Mach 0-6 turboramjet engines.

DESCRIPTION: Studies of combined cycle propulsion systems have shown turboramjets to be one of the most attractive engine concepts in the Mach 0-6 flight regime. Such an engine combines the flexibility and efficiency of the turbojet at flight speeds of Mach 0-4 with the simplicity, low weight, and high specific impulse of the ramjet in the Mach 3-6 flight range. Key enabling technologies for turboramjet development have been identified. Those technologies which are applicable to any turboramjet regardless of configuration (tandem, wrap-around or over/under) are of primary interest in this program. Examples of these technologies include turboramjet ramburner structures, ramburner fuel-injection/flame-holding schemes, endothermic fuel reactor/turboramjet integration, fuel/air heat exchangers, air-driven power generation devices and ramburner cooling techniques. Proof-of-concept testing is preferred, bu analytical studies will also be considered. The goals of Phase I will be to identify a novel concept, quantify its payoff and conduct a small scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate some degree of concept feasibility and plan experiments for Phase II. Larger scale development would be undertaken in Phase II. The goals of Phase III would be to integrate the component developed in Phases I and II into a turboramjet engine demonstrator, and evaluate its performance.

AF91-132 TITLE: Non-Chemical, Air-Breathing, Propulsion Technology

OBJECTIVE: Develop novel, air-breathing, propulsion systems which do not use chemical reactions.

DESCRIPTION: Since air breathing chemical propulsion is limited in the amount of energy and thrust it can produce, and since vehicle concepts are reaching the end of that limit, it is becoming necessary to investigate other possibilities. Phase I goals are to identify concepts that could be viable, non-chemical, air breathing, propulsion systems for future vehicles, and to perform a preliminary performance assessment. Phase II would include a further level of refinement in both the concept and performance analysis. Phase III would involve experimental demonstration of concepts.

AF91-133 TITLE: Multidimensional Architectures for Turbine Engine Composite Structures

OBJECTIVE: Develop weaving and/or braiding techniques suitable for advanced composite components for advanced, gas turbine engines.

DESCRIPTION: Fiber-reinforced composite materials offer properties which enable the designers of advanced gas turbine engines to develop lightweight, high-performance, engine components, including ceramic-composite, air-foil structures. Future, highly structurally efficient components will require three-dimensional fiber reinforcement to achieve the required high stress levels. Current fabrication methods rely heavily on manual weaving, braiding or lay-up techniques, leading to high fabrication costs and problems with repeatability and quality assurance. The purpose of this effort is to investigate the automated fabrication of preforms for composite components for advanced gas turbine engines. The Phase I effort will investigate the feasibility of automating the fabrication of near-net-shape component preforms with full control of fiber orientation and geometry to tailor the mechanical properties of the component. A follow-on Phase II effort will build hardware to test and evaluate the automated technique developed during the Phase I activity. Phase III will take the technique to the stage where it can be used for component production on a commercial scale.

AF91-134 TITLE: Turbine-Engine Test Instrumentation

OBJECTIVE: Develop new sensors/systems for accurately determining strain and temperature under actual, engine, operating conditions.

DESCRIPTION: An area of ever increasing concern in the turbine-engine community is the accurate determination of the strains and temperatures under which engine components must operate. Advanced engine test programs are limited by the problems associated with current structural instrumentation capabilities. The state-of-the-art of structural instrumentation has manyshortcomings in both the strain gauge and thermocouple areas. Current turbine engine tests are particularly impaired by the fact that present instrumentation is commonly temperature limited, short lived, inaccurate, and either protrudes into the gas flow stream or requires trenching the structural component in order to embed the sensor. For these reasons, new sensors/ systems capable of surviving the harsh environments of a turbine engine while providing accurate strain and/or metal temperature data are required. Candidate sensors/systems should be capable of withstanding the temperatures and strains typical of turbine engines for extended periods while detecting strain to within plus or minus 5 percent and temperature to within plus or minus 1 percent. Additionally, proposed techniques should have minimal influence on blade parameters and gas flow path. The goal of Phase I shall be a basic feasibility demonstration of the advanced sensing concept. Phase II goals shall include a full scale demonstration of the technique in an environment which duplicates the anticipated conditions in a modern gas turbine engine. Phase III efforts are expected to include optimization and refinement of the sensing technique, as well as clarification of any unresolved production or manufacturing issues.

AF91-135 TITLE: Compression System Design Methodology

OBJECTIVE: Develop enhanced and advanced compression system and secondary-flow design methodologies.

DESCRIPTION: This is to be achieved by numerous theoretical and experimental efforts including such work as computer modeling, cascade testing, bench rig tests, etc., all adequately documented to be acceptable to the technical community. A major trend in compression system hardware is the increased utilization of low-aspect ratio blading, blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two-dimensional must be extended fully into three dimensions to adequately exploit these trends. Adequate documentation of this work and its influence on turbomachinery is needed as in a comprehensive background document on turbomachinery. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, secondary flow design (including such areas as counter-rotation trenching, labyrinth seals, and disk pumping), time unsteady features of the turbomachinery gas path, and secondary flow systems. Phase I will result in concepts for the development of enhanced and advanced compression systems and methodology for secondary flow design. Phase II will result in software compatible with Wright Research and Development Center systems dealing with advanced compression system and secondary flow design. Phase III will provide hardware to be tested in an appropriate compressor rig for demonstration and proof of concept.

AF91-136 TITLE: Space Power, Energy Conversion, and Thermal Management

OBJECTIVE: Develop survivable and lightweight space power technology for spacecraft applications in the 5 to 100 kilowatt regime.

DESCRIPTION: Develop photovoltaic and thermionic energy conversion source devices, components, materials and subsystems for advanced space power system applications. Proposals should relate to the following technologies: a) high efficiency, highly radiation resistant photovoltaic cells, b) survivable photovoltaic cell stack (greater than 600°C) and c) array configurations, incorporation of novel optical materials and geometries, d) ultra lightweight cells and lightweight/low cost planar and concentrating arrays for application to space missions ranging from a low threat environment to a high-threat environment including tactical missions and electric propulsion for Orbital Transfer Vehicle, e) Autonomous power-management concepts, f) novel power conditioning and distribution devices, g) novel electrochemical devices capable of direct pulse generation, extended life at low earth orbit, and/or lower cost, h) thermionic energy-conversion technology for solar-and/or- nuclear power applications, including, advanced-converter, structural, electrode and insulator materials, novel systems geometries promoting system reliability, i) thermal-control and thermal-management technologies and components for power system thermal control applications, including heat acquisition, transport, and heat rejection for survivable power applications and cryogenic sensor applications are also included. Phase I efforts will be feasibility studies and developments with the goal to demonstrate feasibility of the proposed concepts. Phase II effort goals will be to fully demonstrate the capabilities of the proposed technology as it applies to survivable space-power systems. Phase III efforts are expected to include optimization of performance and final verification of concept capabilities as well as clarification of any unresolved production and manufacturing issues.

AF91-137 TITLE: Aircraft Power and Power Electronics

OBJECTIVE: Develop power electronic devices and systems for aircraft applications.

DESCRIPTION: Develop one or more of the following advanced power and power electronics technologies for future aircraft: (a) high temperature (greater than 500°C) components, fluids, and seals for hydraulic systems; (b) energy-efficient technology; (c) cold weather (-55°C) energy storage technology (batteries, hydraulic accumulators, capacitors); (d) highly reliable, fault-tolerant electrical-power generation and distribution technology; (e) solid state power controllers; (f) high temperature (200°-1000°C) electrical power and distribution components; (g) high temperature (greater than 300°C) magnetic materials; (h) lightweight shafts, gearing clutches, housings, and gearboxes with special emphasis on advanced materials; (i) high performance small turbinetechnology; (j) 270 VDC or 20 kHz electrical power generation and distribution technology; (k) hot aircraft surfaces and secondary power components thermal control; (l) high temperature, radiation hardened power semiconductor devices; (m) advanced converter and inverter topologies for aircraft applications; (o) advanced motor and motor- drive technology for aircraft actuators, fuel pumps and environmental control systems; (p) "smart" power electronic technology for aircraft. Phase I goals include study results, analytical derivations and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III goals include demonstrating flight qualified flight readiness hardware.

AF91-138 TITLE: Strategic and Tactical Missile Power

OBJECTIVE: Develop novel, high-payoff, power-system technologies for strategic and tactical missile as well as silo applications.

DESCRIPTION: The battery/fuel cell power source goals/desired characteristics are: (a) strategic and tactical onboard power: peak power 22 kw/kg in a pulsed mode, active lifetimes from 1 - 60 minutes; shelf life of 25 years without maintenance; 1 second delay or less from initiation to full load; operation over altitude range from sea level to 150 km; operation over temperature range from -54°C to +74°C without power from an external heat source; gravimetric energy density from 25 wh/kg for one-minute lifetimes to over 220 wh/kg for 60-minute lifetimes; volumetric energy densities from 0.1 wh/cc for one-minute lifetimes to over 1 wh/cc for 60-minute lifetimes; size average power range from 0.1 to 10 kw; (b) silo power source: 15 years' inactive lifetime; active lifetimes up to 10,000 hours; 900 wh/kg or greater; 1.5 wh/cc or greater thermal efficiency of 90%; 500 kg or greater modules; (c) silo energy storage: 15 years' lifetime; round-trip energy efficiency 80%; 220 wh/kg; 1 kw/kg peak power capability; 1000 discharges/charges; 0.6 wh/cc; minimum self-discharge rate of 10,000 hours; size 50 kwh or larger. Phase I products will consist of analyses, design studies, experimental verification, and preliminary proof of feasibility demonstrations. Phase II products will include prototypical device performance verification, detailed phenomena characterization and performance optimization studies and analyses. Phase III effort will include flight type quality device performance demonstrations at anticipated operational conditions (environmental and mechanical levels), as well as, qualification testing of units for flight.

AF91-139 TITLE: Pulsed Power for Aerospace Applications

OBJECTIVE: Develop cryogenic, ambient, and high temperature, pulsed power, component technology for aerospace applications.

DESCRIPTION: Development of one or more of the following advanced pulsed power component technologies is needed for future aerospace high power applications: (a) advanced lightweight power sources with power densities less than .02 kilograms/kilowatt; (b) capacitive energy storage devices with energy densities approaching or exceeding 3 kilojoules/kilogram, output voltage of greater than 10 kilovolts, response time of less than 10 nanoseconds, and lifetimes of greater than 10 million pulses per device; (c) inductive energy storage devices with energy densities approaching or exceeding 100 kilojoules/kilograms; (d) repetitive opening switches capable of hundreds to thousands of cycles when interrupting 2-4 megamperes at several hundred volts; (e) closing switches for repetitive switching of average currents of 10-100 amperes at voltages of 100-500 kilovolts; (f) advanced, lightweight, pulse- forming networks for peak power pulses at tens to hundreds of gigawatts with rise times of tenths of nanoseconds, pulse widths of 10-1000 nanoseconds and repetition rates of 10 hertz to 10 kilohertz; (g) high-current, density, pulse conductors that are lightweight with high tensile strength and are suitable for aerospace operating environments; (h) advanced, lightweight, high-voltage, high temperature, radiation tolerant insulation suitable for aerospace operating environments; (i) high temperature, high dielectric strength, low dissipation factor, radiation tolerant power semiconductor devices with a maximum junction temperature exceeding 5000 Kelvin and the ability to switch tens/hundreds/thousands of amperes at 5-20 kilovolts per device; (j) high permeability, ultralow loss ferromagnetic materials for application in passive and active magnetic systems; (k) development of control algorithms and philosophies for the autonomous or quasi-autonomous operation of high power systems in conjunction with their power source for a variety of pulsed loads such as microwave sources and lasers; (l) power sources for RF generators; (m) high power density sources including batteries, fuel cells, turbogenerators, and thermionic energy conversion systems; and (n) superconductivity as applied to pulsed power componentry. Phase I goals include study results, analytical derivations and proof-of-concept experiments. Phase II goals include detailed analytical derivations and prototypical hardware demonstrations. Phase III will involve a full prototypical demonstration.

AF91-140 TITLE: Cost Architecture for Future Air Force Aircraft

OBJECTIVE: Provide the architecture for future efforts in the affordability thrust area.

DESCRIPTION: This effort will provide the basic plan for future procurements and will rely heavily on the skill and judgment of the contract in the cost area. The contractor will develop a cost architecture leading to a methodology for assessing life cycle costs of conceptual aircraft with IOCs in the 2005 time frame. The architecture will reflect the central importance of defining the cost of new and emerging technologies. Due to the uncertainties in the budget, the contractor will define three separate architectures for investments of 1.5, 2.0, and 2.5 million dollars to be spent over four years. The programs will consist of three levels ofcapability including (1) the impact of the budget/force structure on costs and affordability, (2) assessment of unit costs, and (3) the melding of costs with effectiveness. The architecture will include the capability to perform design-to-cost analysis, assess the impact of concurrent engineering, quantify the cost benefit of multirole aircraft vs single function aircraft, assess the impact of operational and performance requirements on costs, quantify the cost implications of advanced technologies, and finally, quantify the impact of future force structure and production rates/quantities on life cycle costs. Phase II will implement the architecture into system design. This architecture must result in a system which is user friendly and provides a post processing capability for generating a wide array of graphic presentations of complex analyses in color.

AF91-141 TITLE: 60 GHz IMPATT Power Amplifier

OBJECTIVE: Develop a 60 GHz Power Amplifier for satellite crosslink communications, using IMPATT Diodes.

DESCRIPTION: The purpose of this project is to design and develop a 10 Watt 60 GHz power amplifier using IMPATT Diodes developed by the Raytheon Company Research Division under contract to the Air Force Space Technology Center. The amplifier will require at least a 4 GHz bandwidth and should have no less than 12% overall efficiency. Wider bandwidth and greater efficiency would be highly desirable. The products of Phase I will be an amplifier design, a specification, and the results of trace studies as to the most effective methods of power combining and diode bias control. Phase II products will be a prototype amplifier and a test report giving the results of operational testing of the amplifier. The specification should include size, weight, power consumption and test procedures as well as power output, bandwidth and efficiency.

AF91-142 TITLE: Nitrogen Tetroxide Spill Vapor Mitigation

OBJECTIVE: Develop method for reducing vapor emissions from nitrogen tetroxide spills.

DESCRIPTION: Nitrogen Tetroxide (N_2O_4) is used as an oxidizer in space propulsion systems by the Air Force. It is a Class A poison and is transported and handled with extreme care. When N_2O_4 is spilled in the environment, the liquid rapidly evaporates to form nitrogen dioxide gas. This irritating gas has low worker and public exposure limits.

The Air Force has developed a vapor-suppressing foam system for N_2O_4 spills. This solicitation is for development of innovative alternative approaches to N_2O_4 vapor suppression. Possible approaches include use of a material to cover the spill until the liquid N_2O_4 can be removed or use of a neutralizing material to chemically convert the N_2O_4 to a non-fuming substance. The use of water on N_2O_4 spills is not recommended because of the resulting vigorous reaction and increase in vapor release. The favored approach would not significantly increase the volume of waste material requiring removal and disposal. The safety and ease of material handling and application are key considerations. Phase I will require a demonstration of the innovative method through lab-scale testing. Phase II will require demonstration on larger scale spills including demonstration of full-scale hardware and material clean-up.

AF91-143 TITLE: Lightweight Hydrazine Vapor Detector

OBJECTIVE: Develop an inexpensive, lightweight, hydrazine, vapor detector for monitoring rocket propellant fuel exposures.

DESCRIPTION: A tenfold reduction in the existing threshold limit values of hydrazine, MMH and UDMH propellants to 10 ppb is anticipated to take effect in 1991. However, no reliable monitor that can be widely deployed to detect the presence of such low hydrazine levels in real time is currently available. A small lightweight monitor that can be deployed at numerous, potential, hydrazine leak, sources is needed. The Phase I proof-of-concept study will emphasize not only sensitivity, reliability and size but also operational costs. Of the three amine fuels, the Phase I effort shall concentrate on UDMH but not to the exclusion of hydrazine and MMH.

The detector to be developed must meet the following requirements:

Sensitivity - Register 90% of the final equilibrated response and recovery values within ten minutes for UDMH concentrations of 10 and 100 ppb, respectively.

Range - 0 to 500 ppb

Precision/Accuracy/ Linearity - At the 10 to 500 ppb region, the maximum output deviation from the ideal linearized output shall not exceed $\pm$25%.

Relative Humidity Effects - The maximum output deviation not to exceed $\pm$20% over a relative humidy range of 20 to 80% and $\pm$35% for 10 to 20% and 80 to 100% RH region.

Selectivity - Rejection ratios of > 100 to 1 for interferents found in space launch environment such as NO_2, ammonia, organic amines, isopropyl alcohol, methyl ethyl ketone and Freons.

Audio Alarm - Equipped with an audio alarm system that can be set to be activated at a selectable concentration.

Batteries - Capable of battery operation for a minimum of eight hours between charges.

Size/Weight - Small and lightweight for portability. A desirable size would be 6" x 4" x 0.5" and a weight of 300 g or less.

Shelf-Life - Stable over six month storage with a maximum allowable change in reading of $\pm$10%.

Calibration - The unit should be capable of being field checked for operability and accuracy.

Cost - The complete unit should be inexpensive (<$200) and the frequently replaced portion of the instrument (sensor section) should be less than $10.

Phase I of this effort will demonstrate, with supporting experimental data, that the proposed approach is capable of meeting the specified requirements. Although several approaches may be initially investigated, one will be selected by the end of Phase I and a preliminary breadboard design of the detector system will be developed. If any features of the monitor fall short of requirements, the contractor must show how and why the specific shortcoming can be alleviated if not eliminated. During Phase II, the breadboard detector developed in Phase I will be optimized to improve sensitivity, reliability and selectivity of the instrument. The work will emphasize monitor refinement and design of a compact total device as opposed to performing a new major research effort. Sufficient quantities of the prototype detectors will be fabricated for field evaluation at an operational facility. Minor modifications based on field test results will be incorporated into a final design of a lightweight, real-time detector.

AF91-144 TITLE: System to Measure Currently Unfulfilled/Partially Satisfied, Environmental, Data Parameters

OBJECTIVE: Develop component and subsystem prototypes to measure unsatisfied or partially satisfied, environmental, data parameters.

DESCRIPTION: This effort should concentrate on the environmental data parameters detailed in Joint Chiefs of Staff Memorandum: MJCS 154-86, Meteorological Requirements for Defense Environmental Satellites, 1 Aug 86. The 43 MJCS 154-86 parameters include clouds, wind, moisture profiles, electron density profiles, and visibility. More than one parameter may be investigated in the proposed effort. Phase I should address a conceptual design development or analysis of currently available technology for optimum data collection components or subsystems. The effort should be aimed at satisfying currently unfulfilled or partially satisfied MJCS 154-86 requirements. The Phase I design should consider satisfying as many related parameters as possible in a single cost effective subsystem. Pros and cons of the proposed subsystem should also be addressed (including impact to spacecraft and ground segments). Power, weight, cost, and state-of-technology constraints should be considerations. Active or passive sensing techniques may be investigated. Phase II should include further development of the Phase I concept into development of a prototype (working laboratory model) of the optimized component or subsystem.

AF91-145 TITLE: Innovative Approaches for Advanced Space Transportation Systems

OBJECTIVE: Define and develop innovative systems which improve military space transportation capability.

DESCRIPTION: Specific approaches are sought to improve the responsiveness, resiliency, and operability of military space transportation capability. Cost reduction of launch and orbit transfer operations, vehicle production and processing should be considered. Risk, both technical and operational, will be evaluated. Special emphasis will be placed on approaches which advance high performance orbit transfer capability (e.g. electric propulsion orbit transfer vehicles). Phase I will establish the technology and methodology requirements necessary to validate the concept and will provide proof-of-concept feasibility to include technical and operational analyses. The contractor will estimate increase in capability over current space transportation systems. Phase II will develop, validate, and demonstrate the approach.

AF91-146 TITLE: Innovative Approaches for Force Support from Space

OBJECTIVE: Identify new and/or improved methods of supporting military forces from space.

DESCRIPTION: Space systems provide critical support for operational military forces, including ground, sea and air. The key support functions include navigation, communications, meteorology and surveillance. The Air Force seeks innovative improvements in these particular capabilities as well as innovative new methods and capabilities to support worldwide military operations. This support may involve current systems or new system types. Changes to current support types might be accomplished with new approaches or the application of new technologies. New support types should be described in sufficient detail to permit evaluation. An example of new technology might include improvements, changes or modifications to computer data links which would ultimately improve military capabilities. To better support terrestrial forces, innovative, small, inexpensive, user friendly equipment is required. Phase I will further the concept and support the feasibility of developing force support from space. Phase II will develop a laboratory model, validate the technology and demonstrate in the laboratory the concept proposed in Phase I.

AF91-147 TITLE: Innovative Approaches for Improved Space-Object Surveillance and Classification

OBJECTIVE: Develop new technologies and innovative systems which improve space object surveillance and classification.

DESCRIPTION: New technologies and innovative systems need to be investigated to improve space object surveillance and classification. Classification should include a determination of the mission and potential hostile intent of space objects. Topics of particular interest include, but are not limited to the following: a) pattern recognition techniques; b) improved resolution and cloud penetration techniques; and c) high-speed image processing. Phase I will define the approach and establish the technology and methodology requirements to validate the approach. The contractor shall provide a rough estimate of anticipated improvements over the existing systems, as well as projected cost savings. Phase II will develop, validate and demonstrate the approach.

AF91-148 TITLE: Variable Power Arcjet

OBJECTIVE: Develop an arcjet which operates efficiently over a power range of six to 14 kilowatts.

DESCRIPTION: Chemically powered orbit transfer vehicles can only deliver 40 percent of initial low earth orbit mass to geosynchronous orbits. Electric rocket engines can double the mass delivered to geosynchronous orbit. These high performance engines use one-half to one-third the propellant of chemical engines, this reduction in propellant mass enables a corresponding increase in payload. The most technically mature electric rocket is the low impedance ammonia arcjet. However, its performance is a strong function of input power. Recent mission studies indicate an operational arcjet may have to accommodate power reductions, due to solar array degradation, of as much as 60 percent without loss of performance. This project will develop a low impedance arcjet capable of operating over a power range of 6 to 14 kilowatts with an efficiency not less than 35 percent and a specific impulse not less than 950 seconds. Phase I will design the variable power arcjet based on low impedance ammonia or hydrazine arcjet designs. The design emphasis will be to maintain at least 35 percent efficiency and 950 seconds specific impulse over a power range of 6 to 14 kilowatts. Phase II will fabricate and test this new thruster on a thrust stand to verify its performance and determine its life time. Proposals will be judged on the understanding of the problem, demonstrated expertise in the field, and the innovative nature of the approach.

AF91-149 TITLE: Innovative Advanced Battery Test Concepts

OBJECTIVE: Develop an accelerated battery testing concept with a high degree of reliability.

DESCRIPTION: Current accelerated advanced battery testing concepts have a low degree of reliability due to the severe stresses placed on the battery cells. To date the only solution has been to conduct real time testing with a few cells for comparison, or simply a run only real time test. Both these options, though superior to accelerated testing alone, have significant drawbacks. Correlating accelerated test data, with a small sample of real-time data, still does not provide a high degree of statistical reliability. Real-time testing requires a significant period of time to develop a statistically significant data base, usually a minimum of 5 years to calculate a 7 to 10 year operational life in LEO. Low reliability and a long lead time for testing are major concerns for satellite designers. Availability of test data and the relevance of that data play a key role in the design of satellite battery systems. Phase I will analytically prove an innovative battery testing concept for an advanced satellite battery design. Some advanced satellite batteries include Super Nickelcadium, Advanced Nickel-Hydrogen, and Sodium Sulfur. Proposals are not limited to only these technologies and other advanced satellite battery technologies may be explored. Due to the radical differences in these technologies, separate proposals may be submitted for differing technologies. Phase II will experimentally verify the results of Phase I.

AF91-150 TITLE: Critical Technology Demonstration for Pulsed Plasma Propulsion

OBJECTIVE: Demonstrate the scaleability of a megajoule class, Magneto Plasma Dynamic (MPD) plasma thruster.

DESCRIPTION: The extension of small, anode centered, MPD plasma thrusters to useful sizes has been limited because the scaling laws were not well understood and because of unforeseen adverse operational characteristics such as parasitic currents. A better understanding of the physics and scaling laws now exists and a number of ideas have been suggested to solve the operating problems at higher energy levels. Thus, a thruster operating in the megajoule regime can be envisioned. At this level, meaningful experiments can be conducted related to particle emission and transport, the assessment and extension of scaling laws, the evaluation of the physics and stability issues, and the measurement of energy coupling. Demonstration of significant levels of exhaust energy should also be a major objective. Phase I should be a limited effort consisting of facility and diagnostic development and subscale tests that provide confidence in the approach proposed for Phase II. Phase II will consist of the development, modeling, and demonstration of a full scale, megajoule plasma thruster. Proposals will be judged upon understanding of the problem, demonstrated expertise in the field, and innovative approaches.

AF91-151 TITLE: Photovoltaic Array Designs

OBJECTIVE: Assess the cost and schedule to construct and space qualify a lightweight, low-cost, photovoltaic array.

DESCRIPTION: For most Air Force satellite missions, photovoltaic arrays are used to generate required electrical power. In accordance with Project Forecast II PT-05, innovative proposals for advanced photovoltaic array designs are solicited. Proposed work plans should assess the cost and schedule to construct and space qualify a lightweight, low cost photovoltaic array. Array hardness to man-made threats is not a primary concern for this solicitation. Long term, reliable array performance against known

mid–altitude orbit environmental conditions is a requirement. Techniques need to be developed such that an array can withstand prolonged exposure to the high energy electrons and protons found in the Van Allen radiation belts. Array performance losses caused by micrometeoroid damage and other environmental effects need to be minimized or eliminated. Array vibrations caused by satellite orbital operations, such as station keeping or electric propulsion orbit transfers, should be estimated and accounted for. Provisions need to be made for stowing,deploying, and orienting the array. Efficient concepts for transferring electrical power from the individual solar cells to the array–satellite attachment point need to be developed. Phase I will produce an engineering design for a 1 to 5 kW array. It will identify the cost and technical drivers for scaling the array design up to 10 to 50 kW. Emphasis should be placed on near-term technology development, large scale producibility and low manufacturing cost. Design parameters are: array specific power greater than 60 W/kg after 5 years in mid–altitude orbits. Phase II will fabricate sample pieces of array hardware. Component and subsystems testing under simulated orbital conditions will be conducted. Extensive analysis will identify the best approach for constructing, testing, and space qualifying a 1 to 5 kW array.

AF91-152 TITLE: In-Flight Solid Rocket Motor Sensors

OBJECTIVE: Development of innovative sensors to monitor solid rocket motor behavior in flight.

DESCRIPTION: New and innovative approaches are being solicited to develop cost-effective, flight weight sensor(s) to monitor the behavior of specific characteristics within a solid rocket motor during flight. Some examples of these specific characteristics are 1) the accumulation of slag in the aft end of burning solid propellant rocket motors and the slags position in the motor as a function of time; 2) the changing propellant web thickness (real-time measurement of propellant burn rate) and the heat transfer rate to the motor case; and 3) the ability to determine the nozzle throat erosion rate. Possible approaches which might show some promise are: (1) acoustic sensors; (2) light weight x-ray and real time radiography; (3) sonar and other sonic measuring devices; and (4) strain gages. Proposed sensors should not have a negative impact on system reliability nor compromise the motor case's integrity and should be applicable for both small tactical motors and large scale ICBMs/space boosters. Phase I will be the proof–of–concept of the approach. Phase II will be the design of the device using the phase I approach, adaptation of the device to flight qualified motors, and ground test verification. Phase III will be the flight test complete with telemetry for data acquisition, retrieval, and data analysis. Particular attention will be given to revolutionary approaches based on sound scientific principles.

AF91-153 TITLE: On–Orbit Supervisor for Controlling Space Systems

OBJECTIVE: Investigate methods for developing on–orbit supervisory control functions for space systems.

DESCRIPTION: Several proposed Air Force missions call for large precision space structures with stringent performance demands and increased operational life. These spacecraft present new challenges in the areas of structures, dynamics and control, and on–orbit health monitoring. Innovative knowledge–based artificial intelligence (AI) systems or neural network systems are sought for providing on–orbit spacecraft subsystem supervision and decision making functions. The expert system should be capable of identifying failures or performance degradation in subsystems and take appropriate actions to either rectify the problem or reconfigure the controls in an adaptive manner to account for the degradation. The subsystems of interest include spacecraft structure, including sensors and actuators required for attitude and vibration control; power and thermal management systems; etc. The proposed AI system should address the following concerns: a) interaction of the on–orbit supervisor with the satellite subsystems; b) data storage requirements for implementing the system; c) real–time data processing requirements. In Phase I, the contractor will identify and evaluate a framework for such a system and study its feasibility. In Phase II, a detailed development will be carried out and the system will be demonstrated on a ground testbed.

AF91-154 TITLE: Concentrator Technology

OBJECTIVE: Develop 9m x 7m off–axis, parabolic, thin-film, seamless, goreless concentrator systems for space flight demonstration.

DESCRIPTION: Two different types of seamless and goreless thin film solar concentrators, one type a flat heliostat 28 feet in diameter, and another type providing a geometric concentration ratio of 10,000:, possessing less than .2 mrad rms slope accuracy error and less than 2mm rms surface accuracy error in an off–axis configuration 9m x 7m. The concentrators are required to increase the state–of–the–art in concentrator technology. It is unknown whether seamless and goreless concentrators greater in size than 1 m can be fabricated and be optically accurate. Seams and gores cause localized surface deviations which cause localized flux deviations. The heliostat is required to have a torus and backplate such that its reflectivity and accuracy may be verified in the Solar Lab at the Astronautics Laboratory. One off–axis parabolic 9m x 7m concentrator with a canopy, reflector,

torus, and truss is required to produce 25 Kw output within a focal length of 4.26m. The concentrator shall be installed and inflated in the Solar Lab to verify its optical accuracy. Four more off–axis parabolic thin film concentrators, complete with canopy, reflector, torus and truss systems will be required; such that they may be packaged one by one in a Getaway Special (GAS) canister to be tested for inflation deployment reliability, in a simulated space environment (zero–g and vacuum), then tested for optical accuracy while still inflated. Phase I shall consist of a literature search and a single preliminary design of a seamless and goreless 9m x 7m off–axis thin film parabolic solar concentrator and the methodology for fabricating one. Phase II shall consist of the detail design and fabrication of the required reflectors, the installation of the heliostat, and the concentrator to be tested in the Solar Lab for accuracy measurements, and packaging into the GAS canister each of the four remaining concentrators before deployment and accuracy testing.

AF91–155 TITLE: Longitudinal Tomography for Solid Rocket Motors

OBJECTIVE: Demonstrate a longitudinal X-ray-computed Tomography (CT) scan of a firing Solid Rocket Motor (SRM).

DESCRIPTION: SRM computational models predict the conditions and behavior of an SRM as a function of time during a burn. SRM designers/analysts want to see processes that range from the normal case to the effects–of–defects, and, in particular, how closely reality parallels their computer models. Currently, the only feedback on the events occurring within the motor during a test fire is very indirect or nonexistent; such information derives from either strain gages or embedded thermocouples, the latter being very expensive and requiring implementation during SRM component manufacture. An approach to provide data is Real–Time X–Ray Computed Tomography (CT). Real–Time CT can provide transverse cross–sectional (i.e. perpendicular to the motor axis) images of the burning motor as a function of time. Cross-sectional images of density as a function of time are a major step forward, but the SRM engineer is more interested in longitudinal cross–sectional (i.e. in a plane containing the motor axis) images. With currently available CT technology, it is possible to obtain a series of contiguous transverse slices so that longitudinal scans are partly realized. Another approach involves cone–beam CT but this approach is far less mature. During Phase I, the contractor will determine the requirements of a CT system capable of providing real-time longitudinal scans of a burning SRM, and shall design a system meeting those requirements. Some issues key to making Longitudinal CT practical are: 1) access to very high intensity x-ray sources; 2) access to high–speed x-ray detectors and corresponding circuitry for data acquisition; 3) ability to configure a CT system to obtain the necessary data without unduly complicating the test procedure, fixturing, or safety provisions; 4) cutting edge algorithm development that allows for reconstruction of images, particularly from incomplete data, cone beam CT, or a combination; and 5) familiarity with SRM analysis requirements including an understanding of the density/strength implications of various materials, and an understanding of bondline problems. Also during Phase I, the contractor will demonstrate Longitudinal CT. This small scale test, as agreed between the contractor and the Program Manager will show a knowledge of the problem and its solution. Phase II shall consist of feasibility demonstrations of the designed CT system. The results from this project will be used to provide direction for future technology programs; to achieve a real-time CT system capable of being integrated into a motor test stand, and providing longitudinal scans during a live firing.

AF91–156 TITLE: Advanced Global Positioning System Receiver for Space Application

OBJECTIVE: Develop innovative technological designs and concepts of Global Positioning System receivers for space application.

DESCRIPTION: The current evolution of defense strategy will undoubtedly place increased emphasis on monitoring and surveillance of adversarial strategic and tactical systems. One of the most suitable and reliable platforms from which such remote sensing objectives can be achieved is the low Earth orbiter. Improved efficiency and accuracy in the deployment, operation, and versatility of such monitoring platforms will require new capabilities in space-based navigation, tracking, and attitude control. Current operations rely on a panoply of ground tracking, attitude sensing, and navigational systems which by the nature of their diversity make it costly to integrate them and difficult to achieve an optimal synergism. As an alternative, much analysis and several programs are in progress to exploit the Global Positioning System (GPS) of satellites to perform some of the navigation, tracking and attitude determination objectives for space vehicles. Receiver developments for space application currently build on conventional technology and methodology designed for Earth-bound user systems and adapt this to the space environment. For example, the Miniature GPS Receiver chipset developed with funding from Defense Advanced Research Projects Agency is a small, lightweight, and low-power receiver suitable for manifesting on virtually any satellite, but it has only conventional navigation capabilities. There is a need to depart from conventional receiver architecture in order to address specifically the unique operational frame of space, the dynamics of spacecraft, and the potential for high-precision, real-time, and multi-function applications in navigation, tracking, and attitude control. The ability for one GPS receiver to perform the functions not only of a precise navigator, but also of orientation and pointing, normally accomplished by star trackers, or horizon and sun sensors, would translate into savings of weight, power consumption, integration costs, and computer requirements, in addition to potential

improved operational accuracy. Therefore, non-conventional, innovative, and novel approaches are solicited for technological concepts and designs of GPS receivers to accomplish high-precision spacecraft navigation, tracking, and attitude determination. Simple proposals include the following, but responses should consider going beyond these basic approaches: 1) modifying the tracking loop bandwidth; 2) providing output frequency in addition to delta phase; and 3) exploiting multiple antenna configurations. Emphasis will be on measuring the GPS carrier signal, but utilization of the coded signals should be considered. All approaches should be oriented toward real-time or near real-time navigation/attitude control of spacecraft in 160 km to 10000 km altitude orbits (higher orbits can be considered) and possible integration with on-board inertial measurement units for autonomous application. Technological design should emphasize application accuracy, but package weight and power requirements figure significantly in the applicability to and success of space mission objectives. Phase I: This phase will investigate and propose novel receiver design approaches and provide preliminary analyses showing the anticipated payoff. Phase II: This phase will design, build, and provisionally test a prototype receiver. Space qualification will not be part of Phase II.

AF91-157 TITLE: Doppler Imaging Photometer for Ionospheric and Thermospheric Dynamics

OBJECTIVE: Design an imaging photometer with Doppler capability to measure ionospheric and thermospheric velocities.

DESCRIPTION: Remote optical measurements of aurora and airglow, both natural and artificial, yield important information on ionospheric structure, dynamics and interaction processes. Because of the close coupling between the ionosphere and thermosphere the relative motion of these regions, especially near auroral arcs, is a critical input parameter to studies of ionospheric irregularity generation and transport. A need exists to couple a Charge Coupled Device based imaging photometer with a high resolution Fabry-Perot etalon to obtain Doppler shift information, and thus line-of-sight velocities, over the entire area of the image. To obtain the required temporal resolution to study auroral arcs, the Fabry-Perot etalon should be scanned as rapidly as possible through one free spectral range, equivalent to a total Doppler shift of 10 km/sec. A sequence of 12 - 15 all sky images during the spectral scan would provide the ionospheric and thermospheric line-of-sight velocity at each Charge Coupled Device pixel. The instrument would need to possess sufficient computational capacity to process these images to produce Doppler maps of dynamics in near-real time. The instrument should be capable of detecting low brightness airglow sources (50 Rayleighs). Other important instrument characteristics would include variable field of view of up to all sky, high spatial resolution, variable wavelengths to separately measure ionospheric and thermospheric emission features, and portability. Phase I would include system conceptual development with key hardware components and system specification identified. Prototype development would be conducted in Phase II, based on results from Phase I.

AF91-158 TITLE: Lidar Mapping of Cloud Tops and Cloud Top Winds

OBJECTIVE: Develop a satellite-borne lidar sensor to map the location and height of clouds and determine the velocity of cloud top motion (winds).

DESCRIPTION: Ranked first and fourth, respectively, in priority on the list of environmental properties in "Military Requirements for Defense Environmental Satellites," (MJCS 154-86), global measurements of the properties of clouds and tropospheric winds have been addressed in several studies, many of which are based on the use of lidar techniques. In general these approaches have been characterized by systems acquiring data only along the spacecraft nadir or by highly complex, and costly, systems demanding extensive spacecraft resources. This solicitation is intended to examine a compromise approach based on lidar backscatter returns from clouds alone. Limiting the observations (sensitivity) to cloud returns should allow simplification in hardware and signal processing and, it is hoped, easier adaptation to existing or planned space platforms. Work under this effort is to concentrate on simulation, sensitivity, and general hardware issues; other efforts currently under way will evaluate howdata limited to cloud returns will apply to weather predication models. The Phase I effort should examine the lidar mapping of clouds using cross track scanning and a level of detection consistent with the anticipated backscatter from thin cirrus and, additionally, such related issues as sampling techniques, slant ranged effects, response to irregular cloud structures, and non-nadir viewing. Analogous factors should be investigated in connection with the determination of cloud top winds. For these simulations, the transmitter should be taken as an eye safe solid state laser(s) operating in the 1.4 to 2.5 micron region. If the Phase I effort demonstrates the reasonableness of this approach from a hardware aspect and OSSEs (Observing System Simulation Experiment) at GL establish that data limited to cloud-top returns are of value to the models, the Phase II work would consist of expansion of the simulation of the cloud top lidar, the specification of critical system parameters, and the characterization of measurement approach.

AF91-159 TITLE: Balloon-Borne Solar Vector Magnetograph

OBJECTIVE: Improve solar flare prediction techniques through very high resolution mapping of solar magnetic fields.

DESCRIPTION: Solar flares interfere with Air Force communications and space operations. While the expected effects can be estimated once a solar flare has been detected, flare onset is unpredictable at present. Recent solar research suggests that the magnetic fields in flare-producing regions of the solar atmosphere come under stress shortly before flare onset. The stressed field elements are undetectable with present telescopes, both because of image degradation caused by the earth's atmosphere, and limitations of current solar vector magnetographs. One way to avoid the former limitation and to develop effective flare-forecast methods is to make high-resolution observations from space or near-space. This could be accomplished with a balloon-borne vector magnetograph, an instrument capable of mapping all three components of the solar magnetic field. Several flights of the magnetograph should lead to a significant improvement in understanding solar flare physical processes and preflare signatures. The instrument should be capable of sub-arcsecond spatial resolution with a magnetic sensitivity of 10 gauss in the line-of-sight component and 50 - 100 gauss in the transverse component. The instrument should also be capable of measuring the transverse flows that drive the magnetic field. Phase I of the effort is for design of a magnetograph, including a telescope of 90 to 120 cm aperture, that can be operated on a balloon-borne gondola at 85,000 - 100,000 feet. To achieve the desired sensitivity the magnetograph must be able to detect partial circular and linear polarization at 250 parts per million over a field of view of at least 3 arcminutes. Spectral resolution must be better than 0.12 Angstrom, achieved, for example with a tunable bandpass filter. Provision should be made for recording and storing or transmitting at least three magnetograms per hour for flights of 10 - 50 hours. The instrument must be able to make several flights per year, with minor refurbishment after each flight. Phase II of the effort is for construction and assembly of the magnetograph including the mechanical support structure and optics for the telescope and specialized optics and image detector (probably a CCD camera). A fine pointer must be provided to stabilize the solar image to better than 0.05 arcsecond. It is anticipated that a pointed platform will provide 10 arcsecond coarse pointing for the instrument.

AF91-160 TITLE: Small Rocket High Altitude Lidar

OBJECTIVE: Develop a high altitude lidar to measure water vapor and possibly other trace gases.

DESCRIPTION: The design of a novel, compact, solid-state high altitude, rocket-borne, lidar system for the detection of water vapor, and possibly other trace gases, is solicited. Water vapor in this region is important because of the effects it has on the absorption of infrared radiation and its effects on surveillance system. This payload would seek to quantify the levels of water vapor and variability as a function of altitude, and seasonal and latitudinal variability, between 15 and 90 kilometers. Other trace gases such as methane, NO_x, and CFCs are also of interest because of their possible effects on atmospheric chemistry and climate. Also of interest is the possibility of detecting atomic oxygen, CO_2, and NO in the region between 90 and 140 kilo-meters. The use of solid state lasers, detectors, and diode pumping should be strongly considered in the design of this system because of the limited power and weight capabilities of the anticipated Nike-Orion launch vehicle. If measurements of atomic oxygen, CO_2, or NO appear feasible consideration to using a Black Brant vehicle, if required, will be given. Conventional Raman, differential absorption, and heterodyne lidar measurement techniques should be considered. Different system viewing geometries should be evaluated to maxmize the system sensitivity. Use of eye safe wavelengths is not necessarily required. It is expected that the measurements will be performed during the descent portion of the flight. Once a design has been developed a comparative evaluation of its sensitivity with other existing sensors such as frost point hygrometers, spectrometers, radiometers, and cryogenic samplers will be performed. Tradeoffs between onboard data storage verses telemetered data should also be evaluated. Recovery and multiple launches of this lidar payload are planned. Fabrication of the lidar payload would be undertaken under the Phase II effort, if justified by the Phase I results, with the completed payload being delivered to the Air Force for launch. It is anticipated that payload verification and test facilities at the Geophysics Laboratory would be made available for flight qualifying of the lidar payload.

AF91-161 TITLE: Transportable Lidar for Density and Temperature Measurements to 110 Km

OBJECTIVE: Develop a trailer-transportable lidar capable of measuring density and temperature to an altitude of 110 km with high accuracy.

DESCRIPTION: AF Rayleigh Lidars are utilized to routinely measure neutral density in the region from 20 to 75 km with a mobile unit and to 95 km with a stationary unit. However, the requirement to measure density above 75 km with current lidar systems has demanded a large receiver and/or a powerful transmitter and thus ruled out the use of a trailer platform. It is envisioned that new alternative lidar techniques with large backscatter cross sections (e.g. resonant fluorescence) could be developed to overcome this limitation. Requirements for the lidar system are as follows: (a) the receiver aperture to be used should have moderate dimensions (primary mirror diameter less than 30 inches (b) the transmitter laser should not require more space than is available in a 8x25 ft trailer, and (c) density and temperature profiles in the region from 80 to 110 km should be specified to an uncertainty better than 10 percent for vertical smoothing of 3 km and a temporal resolution of 15 minutes. In

Phase I, we anticipate the development of the concept allowing high altitude measurements, a design to integrate all identifiable hardware components, and a careful assessment of the expected lidar performance. In Phase II, the proposer will optimize efficiencies, fabricate, and test the system. To minimize the final cost, the use of a 24 inch telescope as well as the existing Rayleigh lidar system, already in place, should be considered.

AF91-162 TITLE: Dissipation of Warm Fog

OBJECTIVE: Determine the feasibility of employing directed infrared energy in the dissipation of warm fog at airfields.

DESCRIPTION: The impact of fog, in particular warm (T > O C) fog, on airfield operations is significant at certain Air Force bases. The problem has re-ceived considerable theoretical study and has been the subject of field experiments using various dissipation schemes. To date, all amelioration efforts have had very limited success in terms of operational techniques for avoiding the closing down of airfields during dense fog episodes. The evaporation of airborne water droplets (diameters 1 to 10 micrometers) by directed infrared irradiation has been demonstrated in the laboratory environment. This proposal is to investigate the feasibility of transitioning the technology into an airfield environment, specifically, the energy needs and component requirements for an operational directed infrared energy fog dissipation system (DEFDS). The minimum capabilities of the DEFDS are to maintain runway visual range (RVR) of at least 400m within the volumes of the approach, touchdown and roll-out zones of an airfield having RVR < 400m on portions of 50 or more days per year. The zone volumes (across-runway width x height x along-runway length in meters) are: approach 60 x 30 x 550, touchdown 60 x 20 x 750, rollout 40 x 10 x 1500. Phase I is a research effort to quantify the dimensions of the problem and to explore design options for DEFDS. Given present and forthcoming directed infrared energy hardware, the research must address the system architecture options, the energy requirements, the power levels, the fog characteristics, the wind conditions, costs, reliability, aircrew safety (especially eye safety), aircraft safety, and environmental implications. The Phase I report must include all these considerations in addition to the general design specifications for a DEFDS. Phase II is a developmental effort which requires the construction and demonstration of a prototype sub-scale DEFDS. Sub-scale means that the prototype DEFDS must maintain RVR > 400m within an environment having RVR < 400m. The volume to be so maintained will be commensurate with the employment of a single (one) moderate power (2 to 20 kW), commercially available directed energy device. In addition to a test site, standard supporting equipment, specifically electrical power and pump components, will be provided by the government. The Phase II deliverable is a final report containing a thorough exposition of the prototype DEFDS and a comprehensive digest of all demonstration results.

AF91-163 TITLE: Microwave/Millimeter-Wave Field Sensor

OBJECTIVE: Develop an electric-field and/or magnetic-field sensor whose response to electromagnetic fields at frequencies of 10 GHz or greater can be calibrated and whose perturbing effect on the field quantity being measured is minimal.

DESCRIPTION: Available microwave/millimeter wave (mw/mmw) field sensors in the 100 MHz-100 GHz range are limited to a useful frequency response below 10 GHz. In addition, at 10 GHz, the electrical size of such sensors is becoming large enough to cause a significant perturbation of the field being measured. It is also quite possible for the field to couple to any conducting leads or cables that are present which can not only perturb the field but also introduce error into the voltage/current signal being carried on the conducting lead. There is a growing requirement for more precise diagnostic capability with an upper frequency response approaching 100 GHz to support planned testing activities in the mw/mmw frequency spectrum. Phase I: This effort will be directed toward identifying a physics principle which can be used as a basis for high-frequency electromagnetic sensor operation. Several physics principles are used as the basis for existing electric/magnetic field (or time derivative) sensors which can function for making measurements at frequencies as high as 20 GHz. This research is directed toward development of approaches which directly measure the field magnitude and not toward methods which only detect the envelope of the field component. The principle to be applied could be previously or newly identified but would have to have supporting analysis which would explain the operation of an EM sensor using it as a basis. The sensors to be developed should be capable of detecting acontinuous wave field produced by radiating sources of 10-200 watts and should have a dynamic range of 60 dB. Pulse waveforms with one nanosecond rise times and one millijoule of energy in a high-noise environment need to be detected. The sensor should be able to be placed inside a cube approximately 30cm on a side without appreciably disturbing the field. The sensor(s) should have a response bandwidth of one octave or more. They should be polarization sensitive with the ability to combine two to detect both polarizations. New sensor concepts proposed under this program do not need to satisfy all of the above requirements; significant improvements in any area will warrant serious interest. The effort should eventually lead to a demonstration by laboratory measurement(s) of the ability of the physics principle to function as an EM sensor. The potential sensor to be derived from a successful physics principle must be of such a nature that it is a candidate for practical operation in the field. The operating parameters required of a field operational sensor include small size, minimal perturbation of the field component to be measured, reasonable detecting/recording electronics and acceptable calibration procedures. Approaches which

require exotic/very expensive materials or very cumbersome support equipment are not likely to be acceptable. On the other hand, any principle which offers capability not currently available will be evaluated. The problem of transporting the signal from the sensor to the recording device with minimal perturbation must be addressed. Phase II: This effort will be directed toward the fabrication and test of a working model of a sensor and identification of problems associated with constructing field-worthy models. Phase III: This effort would be directed toward the design of an operational sensor if the problems identified in Phase II can be resolved. The final step would be a demonstration of the functioning sensor and identification of any special operating procedures or constraints. Successful sensors developed under this program would find use in diagnostics performed under the Air Force Tactical Microwave Effects program and the SDI space system susceptibility testing program. Such sensors would also find extensive use in high-frequency measurement programs being conducted at Lawrence Livermore, Los Alamos and Sandia National Laboratories.

AF91-164 TITLE: Nonlinear Optical Waveguides

OBJECTIVE: Develop nonlinear optical waveguides that are efficient media for degenerate four-wave mixing, phase conjugation. or two-beam coupling.

DESCRIPTION: Nonlinear coupling mechanisms such as degenerate four-wave mixing and two-beam coupling have been successfully applied to current technical challenges such as laser phase locking, aberration compensation through phase conjugation, and probe-wave amplification. The majority of this work is conducted using bulk media to host the nonlinear interaction. Optical waveguides offer properties that could enhance the efficiency of many non-linear coupling mechanisms. For example, the effective length over which nonlinear coupling occurs could be significantly enhanced by the beam-confining properties of an optical fiber. Presently, the small nonlinearities of available optical fibers can be utilized by making use of very long fiber lengths (hundreds of meters). For certain applications however, such long fiber lengths are not acceptable. The purpose of this proposal is to encourage the development of optical waveguides that possess the high nonlinearities of today's popular bulk nonlinear media. Such an innovative development might allow for essential technology to become practical and usable, not just a laboratory effect. Phase I research efforts will be directed towards demonstrating large nonlinear optical effects in waveguide geometries that are centimeters or tens of centimeters in length. These nonlinear effects include the nonlinear Kerr effect, the photorefractive effect, or saturable absorption. Fabrication and delivery of the fibers or planar waveguides shall be an important part of this work. Phase II research efforts will be directed towards the optimization of a waveguide design for a specific application such as wavefront conjugation or laser coupling for use in the laboratory. A finished product must also be delivered. Phase III will consist of design of a waveguide suitable for field use by the Weapons Laboratory. It will also consist of the demonstration of and the identification of operating procedures for a prototype.

AF91-165 TITLE: High-Power-Density Microwave Components

OBJECTIVE: Develop and test techniques and technology for high-power-handling microwave components

DESCRIPTION: High Power Microwave (HPM) sources are being developed by the Air Force for military purposes. These sources generate radio-frequency (RF) fields (100 MHz - 100 GHz) with amplitudes near a breakdown threshold (~100 KV/cm) which limits the power-handling capability and performance of the HPM system. The precise physical mechanisms for this breakdown are not well understood. Differences in surface quality, cleanliness, composition, and microwave characteristics (frequency, pulse length, etc.) seem to be important. It may be possible to increase the power-handling capability of microwave systems by using special materials, treating the structure surfaces, or by designing components (transmission lines, cavities, mode converters, windows, antennas, etc.) in which the electric field strength at the surfaces of the RF structures are low. Proposals are therefore sought for innovative technologies and design techniques which will allow high microwave power densities to be achieved in HPM sources and components without RF breakdown. Phase I will be an experimental and theoretical proof-of-concept investigation of the mechanisms for RF breakdown, with the objective of developing materials, surface treatment techniques, etc. which will significantly raise the RF breakdown threshold. Phase II will apply this technology to develop proof-of-principle high power-handling microwave components with low surface fields and high breakdown thresholds. Phase III will transition high power-handling microwave component technology to commercial applications in the areas of high gradient compact particleaccelerators (for defense, high energy physics research, medicine, electronics manufacture, etc.), RF plasma heating (for magnetically confined fusion, ionosphere modification, plasma processing, gas discharge lasers), advanced radars, directed energy weapons, and a variety of other uses. The immediate customers for Phase III products will be the triservice HPM program, but other, non-defense, customers in the research community, electronics industry, medicine, power-generating industry, etc. should be very interested in utilizing this technology.

AF91-166 TITLE: Measurement of Fluid Quality in Microgravity

OBJECTIVE: Choose concept, develop and demonstrate an instrument to measure gas fraction (Quality) of fluid in a circulating system in microgravity.

DESCRIPTION: Phase I effort will result in defining and evaluating concepts for measuring the gas fraction or Quality of a circulating fluid in micro-gravity, and choosing the most promising concept for additional development. Currently the gas fraction can be measured by gamma density gauges, by vision oberservation in a transparent section of the loop, or by inference from measurements of temperature, pressure, and flow rate; none of these methods are entirely satisfactory. The method chosen for development must be capable of indicating remotely (to a ground station from an unmanned spacecraft), and applicable to fluids which may be used in power conversion and thermal control of spacecraft, such as water, ammonia, the Freons, oxygen, hydrogen, nitrogen, Li, Na, and Nak. One instrument may not cover all fluids of interest, but concepts which cover several fluids or which may be modified to cover several will be of greater interest. The instrument should have a minimum inter-ference with the flow (preferably zero interference). It would be desirable that the instrument operate in the one-G environment on earth also. The initial instrument should be operable with pipes of 1/2 to 1 inch diameter, and should be scalable to other sizes. Volume, mass, power requirements, sensitivity, speed of response, reliability, ruggedness, and lifetime are other factors by which instruments will be judged. Phase II will entail con-structing and demonstrating the instrument in aircraft parabolic flight, sounding rocket, or satellite tests. Phase III will result in a commercial grade instrument which can be used on spacecraft thermal control systems, on spacecraft power conversion systems (Rankine, Stirling), and possibly in terrestrial applications. This instrument will permit the accumulation of more accurate data at a faster rate, and will allow a two-phase space system to be designed with greater confidence and fewer trials. Two-phase systems for space have the promise of reduced mass and much smaller temperature gradients, resulting in a potential for improved design and larger payloads possible for Air Force space based radar, space based communications and other space assets.

AF90-167 TITLE: Lead-Salt Materials Development for Long Wavelength Diode Laser

OBJECTIVE: Design and fabricate a lead-salt laser diode operating efficiently at or near room temperature in the 3-5 micron wavelength region.

DESCRIPTION: Laser diodes can potentially provide low cost, low weight, highly reliable mid-infrared (3-5 micron) sources for many Air Force applications, including optical communications. These applications, however, require sources which operate at high temperature (i.e., as close to 300k as possible) and efficiently. Currently, there are several candidate material systems including compounds and alloys of the II-VI, III-V, and IV-VI families; the latter being the lead-salts. Each of these systems requires increased development of the materials technology for fabrication of suitable laser diodes. The lead-salts are a superior choice in the Auger (non-radiative) recombination of free carriers, which detracts from efficient laser operation. There are several areas, however, in which further study is required to ultimately formulate an optimized laser design from which an appropriate device may be fabricated. These areas include:

-Current substrates, upon which epitaxial active layers are grown, and are beset with large concentrations of defects. In addition, it is difficult to cut, polish and otherwise process lead-salt materials without damage.

-The materials have poor thermal conductivity and there have been instances of unstable interfaces and contacts. Thus, it has been difficult to successfully cycle lead-salt devices. In addition, there are problems with the electrical conductivity of these materials, including the effect of alloy scattering.

-Differential quantum efficiencies of existing lead-salt diode lasers are rather low. Possible contributing factors include leakage currents and non-radiative free-carrier recombination at dislocations and interfaces.

Phase I of this program is to conduct an analysis of current state-of-the-art lead-salt materials technology. This analysis should highlight the previously mentioned areas of concern and other possible deficiencies which may limit the ultimate performance of a lead-salt laser diode device operating in the 3-5 micron wavelength range at or near 300k. Theoretical (including appropriate modelling) and, if possible, experimental consideration must be given to these issues so that an optimized laser diode design, including the laser's predicted operating characteristics, will result from Phase I efforts. Phase II of this program will initially involve fabricating lead-salt laser diode devices, operating in the 3-5 micron wavelength range at or near 300K based on the designof Phase I. Operating parameters of these devices such as threshold current versus temperature, differential quantum efficiency, and near and far field characteristics must be quantified. Following characterization of the initial devices, appropriate design iterations and device fabrication will be performed to optimize laser performance. The laser diodes will be deliverable at

the end of the Phase II effort. Commercial applications which will result from a successful Phase II effort include laser sources for optical communication and pollution control systems.

AF91-168 TITLE: Generation of Singlet Delta Oxygen at High Pressures

OBJECTIVE: Develop a singlet delta oxygen generator that operates at atomospheric, or higher, pressure with yields of 60 percent or higher.

DESCRIPTION: Singlet delta oxygen, an electronically excited state of nolecular oxygen (0(2)(1)delta), is produced through a reaction of gaseous chlorine and a solution of hydrogen peroxide in a base (NaOH, LIOH, KOH). This excited state of oxygen is then used to both dissociate molecular iodine and collisionally excite the atomic iodine lasing species in oxygen-iodine lasers. Presently, singlet delta oxygen is produced in generators (reactors) that operate at relatively low pressure (0.5 - 50 torr) though it has been produced at pressures up to 100 torr. It is suggested that if singlet delta oxygen can be effectively produced at much higher pressures (around an atmosphere), then the pumping requirement for chemical oxygen-iodine laser systems will be considerably reduced. Higher generator pressures would also allow for higher pressures in the oxygen-iodine laser cavity. Higher cavity pressures would have the added effect of forcing the oxygen-iodine laser to saturate homogeneously. A homogeneously saturated (single line) laser would allow for efficient coupling to fiber optics used for potential remote applications (welding and precision cutting) of oxygen-iodine lasers. The goal of this effort is to determine the feasibility of producing steady flows of singlet delta at generator pressures approaching one atmosphere and cavity pressures approaching 50 torr. Then, if feasible, the development of an efficient, high pressure, chemical oxygen iodine laser. The end product of Phase 1 will be (1) a feasibility study of methods for high pressure singlet delta oxygen production, (2) a design for a high pressure singlet delta oxygen generator and, if feasible, (3) a design for a high pressure oxygen-iodine laser. The end products of Phase II will be a detailed design, fabrication and testing of a 0.2 mole per second oxygen generator coupled to a 50 torr or greater iodine laser cavity.

AF91-169 TITLE: Highly Overmoded High-Power-Microwave (HPM) Source

OBJECTIVE: Design and construct a highly overmoded HPM source.

DESCRIPTION: The Air Force is developing high power microwave (HPM) tech-nology for advanced directed energy weapons and to assess the vulnerability of U.S. systems to high power microwave energy. A critical element of HPM systems is the source of microwave energy. Conventional sources employ microwave structures with dimensions comparable to the wavelength of the electromagnetic radiation generated. The power generated in these HPM sources scales like the wavelength squared. A figure of merit for HPM sources is therefore the power divided by the wavelength squared. It has been empirically determined that approximately 1 GW/cm**2 is an upper limit to this figure of merit for microwave tubes with single mode resonant circuits. One strategy for improving the output energy per microwave tube is to build sources which use highly overmoded microwave structures, so that the dimensions of the microwave circuits are much larger than the wavelength of the radiation. Researchers in the USSR have long been developing highly overmoded HPM sources (Multiwave Cerekov Generators - MWCGs) that have demonstrated more than a factor of ten increase in the figure of merit. These MWCGs operate with a diameter to wavelength ratio of nearly twenty. In these highly overmoded microwave sources, the output power appears to scale like the wavelength, not the wavelength squared. Innovative proposals for the design, construction and testing of highly overmoded HPM sources are therefore sought. Phase I of the program will consist of a theoretical proof-of-concept investi-gation of MWCGs and other promising overmoded HPM sources to demonstrate source physics and feasibility. A design for the proposed overmoded HPM source will be produced. Phase II will consist of a series of proof-of-principle experiments to construct and test a highly overmoded HPM source with a figure of merit of at least 10 GW/cm**2 and a Full Width Half Maximum (FWHM) microwave pulse length of a least 0.5 microseconds. Phase III will transition the highly overmoded HPM source technology to the defense industry for incorporation into the tri-service HPM program. This technology will also be useful in the construction of high power radar systems, and compact lightweight charged particle accelerators for medicine, research, and the electronics industry.

AF91-170 TITLE: High-Speed Digital Post-Test Processor for Translated Ground Processing Systems (GPS) Data

OBJECTIVE: Develop a high-speed, digital, post-test processor for translated GPS data with external navigation aiding.

DESCRIPTION: GPS translator data from DoD missile tracking programs is presently received and recorded on specialized ground systems using analog recording equipment. Vehicle performance data is extracted from data tapes by playing them back through program specific ground processing systems which is time consuming and the existing processors are not compatible with each other. These systems are large, complex, expensive and inefficient due to the iterative processing methods employed. Advances in digital recorder and processing technology suggest that a post-test processor can be developed to handle GPS

datarecorded at various speeds and formats, and can accommodate data aiding from external navigation sources. Digital processors could also directly process digital translator data, greatly reducing the front-end processing required for analog translator data. Development of a state-of-the-art processing system would allow test ranges to process translated GPS data for a variety of programs and provide common processing instrumentation among the test ranges. Phase I of this project will develop a system concept for an innovative GPS data processor that will accommodate present GPS translator data tape formats including the Navy Trident Flight Test Support Systems (FTSS) II and the Range Application Joint Programs Office (RAJPO) Translator Processing System plus other pre-detection recorders with I & Q data rates up to 16 Mbps. The processor should be capable of tracking the GPS C/A code from up to 10 satellites in view and extract contiguous delta range parameters for the flight vehicle. Compatibility with existing VAX computers used at many DoD test ranges should also be considered. Data aiding inputs such as radar, IRU's and optical instrumentation should be included in the processing architecture. A design goal would incorporate algorithms minimizing the number of data repeat cycles to achieve optimum resolution of vehicle trajectory data. The final report should provide a detailed description of a system design and identify the key algorithms. Phase II will develop and demonstrate a prototype processing system.

AF91-171 TITLE: Miniature Ground Processing Systems (GPS) Digital Translator

OBJECTIVE: Develop a low-cost, miniaturized, GPS, digital translator with a capability to integrate data into the downlink data stream.

DESCRIPTION: Analog GPS translators have been in use for several years supporting DoD missile tracking programs, however, they have several important limitations: their data stream cannot readily be encrypted, supporting ground stations are highly complex and costly, real time data is difficult to relay and recording requires specialized processing equipment and techniques. Encryption will be required on many new programs which mandate a digital design approach. Digital translators would provide downlink signal margins equal to analog translators plus provide several system advantages. Digital circuitry, especially in the transmitter output stage, would reduce host vehicle power requirements, simplify airborne relay and ground receiving equipment configurations, reduce phase linearity design constraints for the S-band downlink antenna, allow encryption capability, allow data to be input directly to processor digital tracking loops, and allow the use of optimal telemetry diversity combiners at receiving sites. Digitized data could be received at any conventional telemetry facility without significant upgrades. The addition of an inertial reference unit (IRU) would provide position and velocity data during periods of GPS signal tracking loss and would aid real time signal acquisition and post-test data recovery. Phase I will investigate methodologies to digitize GPS satellite signals received by a flight test vehicle translator for transmission to a receiving station over an S-band data link. Innovative methods are sought to integrate IRU data into the S-band data link. The design goal should be a low cost digital translator smaller than the RAJPO state-of-the-art analog translator which is 20 cu. in. and 3 lbs. Design tradeoffs should address high dynamic capabilities to 50g and include operating in a space environment. Phase II will develop and demonstrate a prototype digital translator with the capability to integrate IRU data.

AF91-172 TITLE: Miniaturized Integrated Ground Processing Systems (GPS) and Inertial Navigation Instrumentation

OBJECTIVE: Investigate the feasibility of developing an integrated, microminiaturized, GPS receiver and inertial sensor package for flight test applications.

DESCRIPTION: Current range applications and military GPS receivers with associated navigation aids are too large and heavy for use on a number of flight test programs. Innovative approaches are needed to develop a fully integrated microminiaturized GPS and inertial sensor instrumentation package to improve overall capabilities at reduced cost, size and weight. Potential applications of a microminiaturized GPS/inertial system are for missiles, space vehicles, National Aerospace Plane, Hypersonic Vehicle Technology program and commercial vehicles. Recent advances in GPS and inertial sensor technology indicate substantial reductions in size, weight and cost are possible. A design goal for the package volume, excluding power supply, antenna and cables, should be less than 200 cu. in. Performance goals (one sigma, each axis) are to maintain an absolute accuracy of 50 feet position, 0.5 feet/second velocity, and 0.5 degrees attitude when operating within the conditions up to 20g acceleration and 10,000 feet/second velocity with intermittent GPS data dropouts of up to 30 seconds followed by 60 seconds of GPS track. Differential accuracy should be 6 ft in the X-Y axes and 12 ft in the Z axis under the same dynamic conditions. The system should output inertial sensor and contiguous delta range measurements for post-test analysis. Phase I will develop a conceptual design of a system to meet the packaging and performance characteristics described above. A tradeoff analysis will be accomplished to evaluate GPS receiver and inertial sensor capabilities on system performance. The conceptual design should include a layout of a proof-of-concept system and estimate of physical and electronic specifications for the primary components. Phase II will develop and demonstrate a prototype system.

AF91-173 TITLE: Rawinsonde System with Radio Frequency (RF) Rejection Capability

OBJECTIVE: Develop an advanced rawinsonde system with improved RF interference rejection characteristics.

DESCRIPTION: Balloon launched rawinsondes (sondes) are regularly used on test ranges to measure upper atmospheric winds and telemeter temperature, relative humidity and barometric pressure. The data is used to support meteorological reporting for the National Weather Service and on DoD test ranges to validate vehicle wind load limits during day of launch. Present sondes use super-regenerative receivers which provide very little rejection to RF interference. The number of users within and adjacent to meteorological frequency bands has increased significantly during the last two years, and Loran C sondes experience degradation during storm activity due to electromagnetic discharges. These interference conditions have resulted in considerable data loss from sondes, especially on the Western Test Range. For example, up to 25% of sondes launched during a 4-month period in 1989-90 at Vandenberg AFB experienced data loss causing excessive processing time or the total loss of the sonde. Modern receiver/transmitter and signal processing technology, hardware miniaturization and the use of precision navaids should allow development of a robust meteorological sounding system (MSS) using sondes that can operate effectively in today's dynamic RF environment. Phase I will develop innovative concepts for a balloon launched rawinsonde system to measure atmospheric winds at altitudes up to 110,000 ft and range to 150 miles. The system should be capable of measuring wind velocity within + 1 ft/sec., altitude in 100 ft increments, sonde horizontal position within + 200 ft, and vertical position within + 250 ft. In addition, it should be capable of telemetering temperature, pressure and humidity using state-of-the-art sensors. Reliable data recovery should be possible when operating in a man- made or natural RF interference environment within or adjacent to the meteorological telemetry bands, and the system should maintain continuous track when two or more sondes are aloft simultaneously. Phase II will demonstrate the system concept and produce a sonde prototype with the potential for fabrication in quantity at a cost comparable to those commercially available.

AF91-174 TITLE: Ballistic Missile Research

OBJECTIVE: Develop new concepts and innovations for Intercontinental Ballistic Missile (ICBM) systems and/or subsystems.

DESCRIPTION: This category of innovative concepts is intended to cover all facets of ICBM systems/subsystems research, development and acquisition. It is also intended to provide latitude to the innovator to include areas not specifically addressed by other specific ICBM topics. This general area covers the full spectrum of Air Force ICBM missions (i.e., basing, propulsion, guidance and control, defense penetration, target kill, etc). Emphasis is placed on potential long-term planning concepts. Topics as diverse as new-weapon-system concepts and improved operational techniques can be submitted. This could include studies of heavy weather and cirrus clouds over target areas. Some other areas of interest are high-energy fuels, cooling systems for ICBM basing system, propulsion technology, maintenance-free systems, facility threat, countermeasures, innovative, R&D, organizational concepts, battle-management needs etc. This topic is structured to provide a maximum of innovative flexibility to prospective participants.

AF91-175 TITLE: Advanced Antenna Window Technology

OBJECTIVE: Improve the existing state-of-the-art for reentry vehicle antenna window technology in terms of radio frequency (RF) performance.

DESCRIPTION: Specific areas include (Specify subtopic by letter.)

a. Advanced Antenna Windows: Innovative techniques are sought to address the problem of providing trajectory updates/corrections in both the high endoatmospheric and terminal phase of a Maneuvering Reentry Vehicle (MaRV) trajectory. These techniques must consider and account for the severe ICBM reentry environment which includes plasma levels from 10^{12} to 10^{15} electrons/cm3 and ablation/high heating of antenna windows. Phase I will show prediction techniques for determining errors associated with plasma and antenna ablation/heating using electromagnetic signals (1-35 GHz) for terminal guidance. Phase II will deliver a prediction code validated with BMO-supplied flight-test data.

b. RF Performance of Transpiration-Cooled Antenna Windows: Design and develop an aerothermal experiment capable of measuring the dielectric performance of a transmitting, transpiration-cooled, antenna window under simulated reentry- C- to Ka-band frequencies. The dielectric properties should be measurable during the heating portion of the test. Combined and separate dielectric properties of real-gas boundary layers, coolants, and antenna window materials should be measurable. Structural distortion effects resulting from thermal gradients should be characterized as to their influence upon antenna window dielectric performance. Phase I will design the experiments while Phase II will conduct the tests and analyze the results for BMO-specified materials.

AF91-176 TITLE: Intercontinental Ballistic Missile (ICBM) Flight and Aerodynamic Studies

OBJECTIVE: Continue to advance the state of the art in aerodynamic code development and the modeling of RV reentry conditions.

DESCRIPTION: Specific areas include (Specify subtopic by letter.)

a. RV Flowfield Measurements: Innovative techniques for measuring flowfield properties of reentry vehicles (RVs) during reentry are sought. Information on electron density profiles in the RV boundary layer, temperature, and other flow properties are needed. The measurement method or combination of methods should be able to provide quantitative data over the reentry regime from an altitude of about 60 km to sea level. This encompasses reentry conditions from laminar to turbulent flow boundary layers. Phase I will develop these measurement techniques. The Phase II effort should consist of testing the technique or techniques in a ground test facility which can provide some information on validating the concept.

b. Prediction Tool for Aero-elastic RV Body Motion: Innovative analyses are sought to simulate the flexible body motion under the influence of reentry aerodynamic loads, plume impingement forces, and the body's own spin dynamics. Various modes of body motion should be considered and they should be included in the multi-degree-of-freedom simulation. The aerodynamic motion should be coupled with the body elastic motion. Attention should be focused on the possible onset of dynamic flutter and the determination of the flutter boundaries. Comparison should be made to any ground/flight test data available. The offeror should be familiar with hypersonic aerodynamics, flight dynamics, and aero-elasticity analyses. Phase I will develop the algorithms and outline the necessary model. The Phase II effort should consist of developing a computer model which couples the aerodynamics with the deformed body motion in a dynamic analysis of a multi-degree-of-freedom code.

c. Simulation of Multi-Body Motions in Free Space: A computer code is needed to predict multi-body six-degree-of-freedom motions in free space as well as in atmospherical reentry conditions. This code shall be capable of assessing missile/RV interaction, shroud removal performances, chaff, etc. The algorithm must allow for input of body geometries and be capable of calculating the free molecular, transitional flow and continuum aerodynamic coefficients. The position history of the multi-bodies relative to the radar optical sensors and to one another should be the major output. The numerical algorithms could use various coordinate systems but must have an accurate earth model. Innovation is expected in the areas of six-degree-of-freedom aerodynamic coefficients in both exo-and endo-atmospheric (for bodies such as chaff, decoys, and RVs), selection of the initial conditions, computational time, and the number of bodies allowed. Phase I will formulate numerical algorithms and begin code development. Phase II will focus on code completion and validation against flight test data.

d. Exploratory Real-Gas Effects Test with Free-Piston Shock Tunnel: Plan, perform, and reduce data for an exploratory free piston shock tunnel test for real-gas ballistic missile reentry aerodynamics. The testing should include design and fabrication of the model and installation of appropriate instrumentation. The purpose of the testing is to explore the usefulness of shock tunnel facilities for obtaining high-altitude real-gas measurements for aerodynamic code validation. Data reduction should incorporate results into an appropriate reentry code. Phase I will consist of test plan preparation while Phase II will conduct testing and validation.

AF91-177 TITLE: Intercontinental Ballistic Missile (ICMB) Electronics Design

OBJECTIVE: Explore critical electronics which improve projected ICBM mission capability.

DESCRIPTION: Dielectric Resonator Oscillator: Some Ballistic Missile Organization (BMO) avionics require stable sources (Voltage, Current, etc.) for flight hardware. Stability of 1 part per million (PPM) must be maintained over somewhat broad ranges of environmental conditions (e.g., temp of -55°C to 125°C). A viable base for any reference signal is a well-controlled oscillator (clock). The stable oscillator should be "locked"by a circuit element which tends to be unaffected by variations in environmental conditions. The dielectric resonant oscillator is dependent upon just such a frequency firing device. The envisioned oscillator should run at a high enough rate (e.g. K_u Band) that 1×10^{-6} represents a data sample which is large enough to be easily manipulated with stable wide band conditioning circuitry, e.g., translate zero crossings into voltage level. Hardware must be MMIC (or at worst hybrid MMIC) producible for missile usage. Phase I should consist of designing a microwave oscillator based upon dielectric resonator which demonstrates an operating stability of 1 PPM. The study/design must evaluate stable operation over environmental conditions for USAF Ballistic Systems environmental parameters to be supplied by BSD. Study/design(s) must indicate capability to be produced in microwave monolithic integrated circuit. If hybrid circuit is required, (e.g., dielectric bead), the remainder of the oscillator and its associated circuitry must employ the maximum of monolithic hardware. Phase II should design 3 oscillators, plus associated circuitry to demonstrate oscillation stability of 1 PPM plus associated reference transformation (voltage or current) at the same degree of stability.

AF91-178 TITLE: Weather Prediction for Reentry Test Launch Decisions

OBJECTIVE: Develop analytical tools to evaluate the performance of existing cloud modeling models in the use of reentry test launch decisions.

DESCRIPTION: Atmospheric water content inhibits the collection of infrared data from missile reentry tests. To facilitate weather-related launch decisions, new analytical tools need to be developed or existing codes must be refined for Kwajalein area weather prediction. This prediction shall be utilized in making launch decisions which optimize infrared (IR) data collection. Phase I will investigate the existing state-of-art codes and tools in this area and identify an approach for broad use at Kwajalein. Phase II will develop a new or hybrid model based on the Phase I recommendation.

AF91-179 TITLE: Advanced Battery Technology for Intercontinental Ballistic (ICBM) Missions

OBJECTIVE: Develop increased battery efficiency for ICBM basing and reentry power/packaging requirements.

DESCRIPTION: a. High Energy Density Rechargeable Batteries: The Air Force currently uses rechargeable lead-acid batteries of conventional design for emergency power and high-energy, lithium, primary batteries for long-term survival power in Minuteman and Peacekeeper silos. In the future, these batteries may be replaced with improved rechargeable batteries if performance and cost can be enhanced. Significant performance parameters of the desired batteries include energy storage capacity of up to 10,000 amp-hours for a 28 volt system, a minimum of 100 cycles over a ten to 15 year time period, minimum maintenance requirements, and a storage life of ten to 15 years under float charge if necessary. Additionally, high hardness of the battery for nuclear weapons environments is also desirable. During Phase I, anode, cathode, and electrolyte systems should be explored and cells of up to 100 amp-hour should be tested. In Phase II, a 1000 amp-hour cell should be demonstrated and battery designs provided that establish the feasibility of scale up to at least 4000 amp-hours capacity.

b. Bipolar Lead Acid Technology: Secondary (i.e., rechargeable) battery systems offer advantages for systems which have long stand times but also require periodic operations in test cycling models. The lead acid battery offers high energy density, mature chemistry/material technology, and high cycling life. Basically, this battery capability incorporates over 100 years of product fine tuning. The bipolar construction offers improved power/energy density, and more rugged construction. Sealed operation projections indicate that bipolar construction offers smaller, more compact, battery design with a possibility of missile sized rechargeable units. Phase I of this effort would investigate design(s) of sealed bipolar lead acid batteries for two sizes of a USAF missile platform i.e., R/V and decoy sized flight vehicles. Phase II would consist of the fabrication and testing of 40-50 test batteries in each of the two sizes designed in Phase I. Ten units of each design would be delivered to BMO for independent evaluation.

c. High Voltage Cathodes: Cathode couples for voltage cells operate in the range of 1.5-2.5 volts, although some proposed lithium based designs promise voltages approaching 4 volts. For operation as a battery vs cell, a string of cells must generally be connected to achieve desired operating voltage levels. Concepts are sought which explore new cell cathode/electrolyte approaches which give a minimum of 4 volt. The objective is to investigate the design of a high power (10-40 amp) short lived (30 sec) battery capability where packaged minimum cell voltage ranges from 4-6 volts. Battery voltages desired for missile systems would range from 12-40 volts. Phase I will investigate designs of cathode/electrolyte chemistry offering a 4-6 volt cell in the packaged configuration. Designs must show battery capability of 10-40 amps over a 30 second discharge with 12-40 volts. Phase II will develop 50 "AA" sized batteries which demonstrate the values delineated in Phase I. 10-20 battery units will be delivered to BMO for independent evaluation.

AF91-180 TITLE: Intercontinental Ballistic Missile (ICMB) Basing Security Techniques

OBJECTIVE: Increase the capability to detect and deter enemy surveillance of land-based ICBM systems.

DESCRIPTION: a. New concepts for Security Surveillance Systems: Mobile ICBM systems create severe challenges for physical security. Rough terrain with vegetation, public access potential, poor visibility in bad weather, and countermeasures all make intrusion detection, classification of nuisance alarms, and estimation of intruder intent difficult. New approaches to signal and image processing are under intensive study for both defense and commercial applications. Continuous sensor improvements have resulted from a better understanding of the physics and chemistry of detectors or from superior manufacturing processors. Applications of these advances in innovative ways can lead to better surveillance system performance at lower cost. Phase I should investigate one or more advanced technologies or innovative system concepts, and include technical feasibility and performance improvement analyses. Phase II should consist of hardware or software test demonstrations of key innovative features.

b. Innovative Surface-Mapping Techniques for Tag/Implant Detection: Detection of concealed electronic or other devices, designed to support hostile location and attack of missile launchers or control centers, is currently a time-consuming undertaking, involving complementary procedures and equipment. Surface-mapping techniques using one or more novel phenomenologies may be able to significantly reduce the time, manpower, and cost of such operations. The mapping device must sense surface anomalies such as concealed ports, slots, wires, solid state devices, or infrared (IR) reflectors. It must also be able to discriminate between man made features and natural or unplanned irregularities caused by aging, manufacturing imperfections,or damage. The mapper must be non-destructive and non-hazardous. Potential techniques might involve eddy currents, ultrasonics, stress concentrations, laser holography, and signal processing. Phase I should consist of an investigation, selection, and feasibility analysis of candidate concepts. Phase II could involve further investigation, exploratory testing and concept demonstration.

AF91-181 TITLE: Advanced Heatshield Studies

OBJECTIVE: Improve the existing state-of-the-art for reentry (RV) vehicle heatshield capability under extreme thermal and structural parameters.

DESCRIPTION: a. Enhanced Heatshield Capability: Develop innovative methods to improve current ablative performance and weight characteristics of heatshields for a maneuvering reentry vehicle (MaRV) flying long, heat soaking trajectories. Perform ground testing to determine the amount of ablation, surface temperatures, and material strength required under MaRV conditions. Develop analytical capability to perform heatshield weight and sizing requirement specifications with a PC based CAD code for input/output. Special emphasis will be on a high-performance heatshield material that can demonstrate superior ablative performance while providing a weight advantage. Phase I will define the requirements and begin code development or modification. Phase II will continue validation and perform ground testing.

b. A New Heatshield for Advanced Reentry Vehicles: Current carbon phenolic heatshield material does not provide the strength properties necessary for advanced RV applications. Innovative concepts are sought which investigate material candidates that provide RV substructure strength properties and heatshield thermal properties while utilizing a single composite. The composite material should be tailored into desirable strength properties with good ablation characteristics. Phase I will investigate potential concepts and either select or reject candidates based on analysis. Phase II will concentrate on the ground testing of composite material

AF91-182 TITLE: Air Blast Response of Low Drag Shape Launcher Vehicles

OBJECTIVE: Explore innovative concepts involving fixed and variable profile aerodynamic shaping to increase vehicle slide resistance to air blast.

DESCRIPTION: Very-hard-surface, mobile launch vehicles must resist sliding motion when exposed to the side-on or head-on air blast from a nuclear burst. Innovative ways of aerodynamic launch-vehicle shaping can help limit sliding. Blast overpressures of 100 to 150 psi are of interest with maximum, vehicle, width-to-height ratios of less than six. Phase I will explore the various aerodynamic shapes (section profiles) and identify promising options using simplified loading analysis based on available data and methods. Phase II will involve more detailed analysis and shock tube/wind tunnel tests to determine the transcient loading characteristics. A simplified transient slide motion response model will be developed to evaluate the selected shapes.

AF91-183 TITLE: Seismic Detection Countermeasures for an Advanced Basing Concept

OBJECTIVE: Characterize and evaluate low-cost techniques to counter seismic-signature detection of Intercontinental Ballistic Missile (ICBM) launcher vehicles.

DESCRIPTION: We are seeking innovative means of countering detection of the movement and location of mobile ICBM systems from seismic signatures. Focus of this study is on launch vehicles in tunnels 30 to 50 feet below the surface. Launch vehicles of upwards of 500 Klbs traveling at speeds of one to ten mph are of interest. The basing area of approximately 200 miles may be fenced; however, threat sensors deployed either inside or outside the fenced area should be considered. Phase I will characterize the signature characteristics and countermeasure techniques for various threat sensor/jammer location scenarios and define the analytical models and evaluation techniques. Phase II will analyze selected full scale and subscale validation example senarios and conduct small scale validation tests.

AF91-184 TITLE: Aerodynamically Stable Intercontinental Ballistic Missile (ICBM) Booster Design Improvements

OBJECTIVE: Explore and analyze innovative means of improving aerodynamically stable ICBM designs.

DESCRIPTION: Fast burn boosters can be designed in such a way as to reduce system weight and improve aerodynamic stability when compared to conventionally designed boosters. Improved stability may lead to other design enhancements which could result in reduced systems cost, reduced complexity, and improved reliability. Suggestions for such booster design improvements are sought. Phase I will identify candidate booster design improvements and characterize to first order their performance, manufacturing, and maintenance implications. In Phase II, booster design improvements identified and tentatively verified in Phase I will be assessed through detailed analysis. Uncertainties that could threaten concept viability will be noted. Detailed test programs for verification of concepts will be generated.

AF91-185 TITLE: Unconventional Antennas for Intermittent Transmission from Mobile Intercontinental Ballistic Missile (ICBM) Assets

OBJECTIVE: Provide the capability for long-wave or other radio transmission from mobile assets without large structures or support equipment.

DESCRIPTION: Large antennas can be difficult to deploy, susceptible to nuclear and other damage and limit the mobility of missile assets. The purpose of this effort is to develop concepts which eliminate these disadvantages. In addition, the antennas and communications mode must not reveal the location of mobile assets to long-range, enemy, direction-finding equipment. The antennas must be capable of rapid automated deployment in a hostile environment. A large number of transmissions, each lasting up to five minutes, is a system requirement. Phase I proposals should suggest possible candidates and present a plan for feasibility analysis and selection of preferred concepts. Phase II should involve additional investigation, testing, and concept selection.

AF91-186 TITLE: Freon (CFC 113) Solvent Replacement

OBJECTIVE: Develop Replacement(s) for Freon (CFC 113) Solvent as a Cleaning Agent.

DESCRIPTION: Chlorofluorocarbons (CFCs), and Methyl Chloroform are two major sources of Atmospheric Chlorine that is devastating the ozone layer. CFCs will probably be completely banned by the year 2000. Both of these chemicals are widely used flushing/degreasing agents in the production of metallic and electronic DoD materiel. In some applications they are used as simple hydro-carbon solvents, but in other applications they are used not only as a solvent for specific, complex contaminates but also a high shear rate particulate (contaminate) remover. The intent define and categorize the contaminates for which CFC, Trichlorethane (TRIC) 1.1.1, and Hydrogenated Chlorofluorocarbons (HCFCs) are used in relation to DoD missile guidance system hardware and to determine the effects they have on the surface chemistry/physics of the components of which they are applied. Then, using this knowledge, select alternative materials that will produce similar benefits.

As an example the manufacture of reliable, inertial-guidance, system gyros require cleaning processes that involve particulate removal under high shear forces together with dissolution of silicon, bromine, and halo-alkane (CTFE) materials from the surfaces of beryllium components. To date no aqueous-based cleaning fluids or other environmentally acceptable solvents have been found that will produce required levels of cleanliness (which is being accomplished by the use of Freon CFC 113, and Trich 1.1.1). The relatively new HCFC family of solvents may be effective but they must undergo extensive testing and, if they become approved, may cost 3 to 4 times the cost of Freon CFC 113. Adequate cleaning of electronic components is another totally different problem. The Phase I deliverable is anticipated to comprise a detailed report plus a proposed test program for potentially successful cleaning materials and/or systems. Phase II will consist of the actual test program implementation.

AF91-187 TITLE: Freon-Type, Solvent-Recycling, Spray Booth

OBJECTIVE: Develop a design for a Class 100 environment spray cleaning booth to completely contain and recycle Freon (CFC 113), Trichlorethane (TRIC) 1.1.1, Hydrogenated/chlorofluorocarbons HCFCs and other chlorinated low-boiling-point solvents in a manner that is environmentally acceptable.

DESCRIPTION: The manufacture of reliable, inertial-guidance, system gyros require cleaning processes that involve particulate removal under high shear forces together with dissolution of silicon, bromine, and halo-alkane (CTFE) materials. To date no aqueous-based cleaning fluids or other environmentally acceptable solvents have been found that will produce required levels of

cleanliness. CFC 113, TRIC 1.1.1 and HCFCs will provide the required cleanliness but must be completely contained because of the adverse effect the decomposition products of these materials have on the atmosphere. When these solvents are used to clean inertial guidance system components, typical contamination levels of the sprayed solvent must be maintained at less than 5 Parts per Million (PPM). The laminar flow solvent stream issuing from the spray apparatus should be capable of up to 100 psi nozzle pressure. In addition to the laminar flow spray capability of the booth a vapor degrease capability would be a desirable addition. Contamination products resulting from the solvent recycling process must be contained and capable of being removed from the unit in a manner that does not release any solvent to the atmosphere. Similarly parts to be cleaned and cleaned parts must be able to be loaded and unloaded from the unit without any solvent loss. On-line, real-time monitoring of the solvent contamination level is a requirement. The design concept should be capable of single station and multiple station configurations. On-line, "leak to the atmosphere" detection capability should be integral to the design concept. Phase I deliverables shall encompass a completesystem design. Final product cost, operational efficiency and maintenance costs will all effect the commercial acceptance of the unit. Phase II activity will involve a demonstration of a prototype unit.

AF91-188 TITLE: Fibre-Optic Cable Connector

OBJECTIVE: Develop high-reliability, optical, cable connectors for missile-related, laser, ordnance, firing systems.

DESCRIPTION: Fibre optic cables are utilized in missile ordnance firing systems. A vital component in such systems is the fibre optic cable connector used to join one optic cable segment to another. Serious power loss through the connector is frequently experienced after relatively few (3-5) functional test cycles. Analysis has shown that the causes the power and/or attenuation losses are varied:

1. Input cable-to-connector mismatch

2. Improper preparation of the end of the input cable that interfaces with the connector: improper cut off; improper polishing; cracked or split cable

3. Contamination and/or improper cleaning of cable-to-connector interface during mating/demating operations.

4. Fibre-optic breakage during laser, ordnance, firing-system, component manufacture.

5. Burning and/or melting of the fibre-optic cable sheath at the input cable-to-connector interface as a result or one or more of above power loss causes.

A need exists to enhance fibre-optic cable connector design, producibility, manufacturability and functionality to a point that will insure extremely high reliability over a minimum of 10-30 operational cycles (depending on the specific application requirements). The firing systems that relate to this SBIR solicitation requires each fibre optic cable (each fibre), to handle 500-1000 millijoules of pulsed laser energy with an optical loss of less than 1.0 db per fibre through the connector. Laser energy sources that may be used in various systems include: 1) Ruby Laser - 694.3 nanometers, 2) Gallium Arsenide Laser Diodes - 860 nanometers, 3) Neodymium Laser - 1060 nanometers, and 4) CO_2 Laser - 10,600 nanometers.

The connector design requirement dictates that the connector will be producible in both single-channel and multiple-channel configurations.

Phase I SBIR activity will result in a generic, fibre-optic, cable connector design wherein emphasis has been placed on: 1) Producibility, 2) Factory repair/rework, 3) Easy/accurate/contamination-free assembly/disassembly (mating/demating), 4) Single channel/multiple channel configuration, 5) The "match" between the input cable and the connector must be precise and maintained during the operational temperature and vibrational load test environment, and 6) Ease of cleaning without fibre damage and freedom from contaminate infiltration retention. Phase I SBIR activity will also address detailed fibre optic cable preparation procedures prior to connector assembly. A single channel connector demonstration prior to the end of the Phase I activity is desired. A demonstration should be conducted utilizing one of the above laser sources at 500 millijoules (min) of pulsed laser energy at less than 1.0 db of energy loss after each successive disassembly/assembly. The demonstration would be conducted in a non-vibrational, room ambient temperature environment. Phase II will involve construction and test of selected designs in the operational test environment.

AF91-189 TITLE: Fluid Mechanics

OBJECTIVE: Improve understanding of flow to improve performance of aerospace systems.

DESCRIPTION: The Air Force invites basic research in fluid mechanics to provide scientific knowledge and information on the behavior of complex flow fields associated with aerospace vehicle configurations and flight regimes of importance to the Air Force. The research seeks to understand key fluid flow phenomena, to devise improved theoretical models for aerodynamic prediction and design based on that understanding, and to originate flow control concepts to expand current flight performance boundaries. Research emphasizes the development of computational methods for accurate and efficient numerical solution of the equations of fluid dynamics, the role of turbulence in the prediction and control of shear flows, the dynamics of separating unsteady flows such as those occurring in rapid dynamic maneuvers, and the complex internal flow environment of gas turbine engines.

AF91-190 TITLE: Multifunctional Nonmetallic Materials Processing and Characterization

OBJECTIVE: Develop new nonmetallic material concepts for unique combinations of electro-optical and nonlinear optical, electromagnetic and structural properties

DESCRIPTION: Advances in ceramics, glasses and polymers are expected to come from the control of features at the 100 A to 1000 level (ultrastructure) via chemical synthesis and processing methods. These materials may take the form of ultrastructural level structures and composites which will perform a combination of active and passive functions. Processing includes new and improved materials based on the methods of organic, inorganic and organometallic chemistry as well as sol-gel, micromorphology processing, transformation processing, emulsion chemistry and other innovative processes. Imaginative combinations of these processes are of interest for materials with nonlinear optical, magnetic, superconducting and/or semiconducting properties and phenomena and structural integrity. Subpicosecond, nonresonant or near-resonant low power optical polymers, organics and inorganics or combinations thereof are specifically required. Molecular composites, which would include the analogs of macroscopic composites, biological and natural systems as well as new synthetic combinations, are of interest. Device applications should be considered, particularly where the ultrastructured material will serve as a self-contained functional entity. New organic and inorganic polymers as well as oxides and non-oxide nonmetallics are needed for these multifunctional ultrastructures. New mechanisms and reactions are considered important components of nonmetallic materials processing and synthesis. Phase I must provide sufficient material for proof-of-principle. Phase II must make available both well characterized material and processing know-how for high volume, high yield.

AF91-191 TITLE: Quantum Structures and Devices

OBJECTIVE: Improve capabilities of high resolution radar systems and high capacity communication systems.

DESCRIPTION: Recent advances in materials processing and fabrication techniques have made it possible to produce device structures with characteristic dimensions down to a few atomic layers. New classes of devices are emerging or being conceived. Many of these manifest quantum mechanical effects such as tunneling (two- and three-terminal resonant tunneling structures), quantum phase interference (Aharonov-Bohn effect) or coherence (Bloch oscillators). Proposals are invited addressing processing, fabrication, characterization and modeling of quantum devices. It is important that fundamental issues be addressed while concentrating on devices with realistic potential for DOD applications. Particularly relevant are devices with possible high-frequency or high speed applications. In modeling efforts, proposals are encouraged that incorporate self-consistency and dissipation as well as realistic boundary conditions. As this topic addresses a subject at the cutting edge of technological and theoretical capabilities, rapid progress may not be possible in Phase I. However, it is expected that Phase I clearly demonstrate the feasibility of the proposed approach and establish a convincing Phase II research program.

AF91-192 TITLE: Novel Precursors for Very-High-Temperature Composites

OBJECTIVE: Develop new precursors for very-high-temperature, ceramic-matrix, and carbon/carbon composites.

DESCRIPTION: Ceramic matrix and carbon/carbon composites hold great potential for use in advanced structural applications where light-weight, strong components must operate in harsh environments. Microstructure and interface control is crucial in determining the final properties of these materials. We seek new, innovative precursors for the matrix that allow control of the stoichiometry and tailoring of the microstructure to give control over properties such as thermal expansion and oxidation resistance. Precursors for liquid and chemical vapor infiltration are preferred, although those for other processing techniques will be considered. Problems of interest include, but are not limited to atomic scale incorporation of oxidation inhibitors, precursors that contain molecules with the final matrix stoichiometry and structure, variable molecular weight precursors, and precursors for selective area deposition. Phase I must provide enough material for proof-of-principle. Phase II must make available both well characterized material and processing know-how for high volume, high yield.

AF91-193 TITLE: Growth of Organic Semiconductor Heterostructures

OBJECTIVE: Develop new, organic, semiconductor, heterostructure systems with unique, electronic electrooptic, nonlinear optical properties.

DESCRIPTION: For many years, hope has been extended that organic materials have potential in active electronic device applications. Although this promise has remained largely unfulfilled, it has developed out of the realization that the variety of organic compounds with a wide range of both optical and electronic properties is unlimited, with several thousand compounds being readily available. In spite of these difficulties, considerable progress has been made in the last decade in realizing practical, active electronic and optoelectronic devices where an organic material forms an integral part of the device structure. One promising approach employs an organic film that is layered onto the surface of a conventional inorganic semiconductor substratesuch as Si, GaAs, or InP to form an insulating or conducting layer that controls the distribution of electric fields and hence the transport of charge within the device. An attractive feature of such devices is that the composition of the organic film can be altered only slightly to effect large changes in its optical and electronic properties. Furthermore, the cohesive forces that bind molecules within these organic semiconductors are due to the relatively weak Van der Waals dipolar attraction. Hence, the materials are somewhat soft (as compared to Si, for example) and can be layered without inducing strain onto a variety of semiconductor substrates. Thus, the organic/inorganic semiconductor growth process need not be limited by the constraints of lattice-matching. We invite research to develop new organic-inorganic devices employing thin layers of crystalline organic semiconductors layered onto inorganic semiconductor substrates. The goal is to demonstrate the growth of these organic-on-inorganic semiconductor heterojunctions followed by possible device applications. Phase I of this program should demonstrate the growth of selected new crystalline organic semiconductor layers. Phase II should allow for the appropriate material characterization of the layers grown in Phase I and demonstrate particular device structures. Both phases should provide enought material or structures for proof-of-principle.

AF91-194 TITLE: Ecotoxicology Research

OBJECTIVE: Develop inexpensive techniques for long-term monitoring, contaminated site treatment, and environmental toxicology.

DESCRIPTION: The Air Force recognizes that inadvertent and accidental spills of hazardous materials can occur. Hazardous materials like fuels and fuel components, solvents, pesticides, and heavy metals have made clean-up and monitoring of contaminated sites formidable. Inexpensive methods for monitoring contamination levels and mobility of contaminants at spill sites is needed. Clean-up of hazardous waste materials, by means which are not intrinsically toxic or which result in more toxicants, presents another demanding obstacle for the Air Force restoration program. Inexpensive and effective measures for site clean-up (i.e., bioremediation, bioreclamation, etc) are needed. Finally, the mechanisms whereby hazardous materials cause their toxic effects on the environment, at any ecosystem level, also require analysis and explanation. Phase I products are expected to be a source design of approaches to site clean-up options. Any Phase II effort must demonstrate mechanisms/techniques efficacy at clean-up.

AF91-195 TITLE: Efficient Techniques for Signal/Image Analysis and Reconstruction

OBJECTIVE: Investigate innovative techniques for the reconstruction of multi-dimensional data objects, such as visual scenes.

DESCRIPTION: Many Air Force systems involve the processing and interpretation of visual and other electromagnetic data. Examples are remote sensing systems, terrain-following systems in missiles, and arrayed radar systems for tracking. In many cases, theoretical limits on computational power in the active environment necessitate the use of data compression to enable enough scenes to be transmitted and processed. Furthermore, distortions introduced into the transmission through noise, blurring, and attenuation must be taken into account. New paradigms such as wavelet analysis, inverse diffusion processes, and computational geometry appear to be useful in developing more efficient signal/image reconstructive methods. Proposers may have one of these methodologies, or some other innovative technique, in mind. A sound theoretical framework for the particular mathematical approach is essential. Viability of the approach should be demonstrated on problems arising from sensor fusion, terrain recognition, transmission through distorting medium, or a similar problem of Air Force interest. Any phase II effort would demonstrate prototypes to the point where phase III production and marketing funds could be attracted.

AF91-196 TITLE: Compact, Spectrally Bright, Short-Wavelength Sources

OBJECTIVE: Study, demonstrate, and develop compact, coherent, radiation sources in the ultraviolet to x-ray spectral regions

DESCRIPTION: The Air Force would have many important uses for compact, efficient, coherent, radiation sources within the wavelength region between the x-ray and ultraviolet spectral regions. Electronic material, device, and circuit processing and diagnostics, real-time flow diagnostics and control, and surface preparation and studies are some important examples. A variety of new possibilities for achieving such sources are becoming available, including laser, nonlinear optical, and electron beam/material interactions. Sources based on these, or any other innovative suggestions, will be considered. Phase I products are expected to be a source design, experimental plan for demonstrating that design, and resolution of any major uncertainties in achieving a source based on that plan. Any phase II effort would demonstrate prototypes to the point where phase III production and marketing funds could be attracted.

AF91-197 TITLE: Tire-Wear-Prediction Techniques for the National Aero-Space Plane

OBJECTIVE: Determine the tire-tread-wear mechanisms and develop tread-wear-prediction techniques for the NASP.

DESCRIPTION: Tire tread wear for the NASP will be more rapid than that currently experienced on high-performance fighters and the space shuttle. The NASP tire will push the durability limits of existing tires in terms of takeoff/landing speed, spinup inertia, and inflation pressure. Wheel-well soak temperature prior to landing is also a consideration. An analytical prediction technique is required to advance tire technology for NASP applications. An understanding of tire-tread-wear mechanisms associated with high-speed tire operations (spinup, braking, cornering, and free rolling) will be used to guide the development of the tire wear model. Sensitivities to such parameters as tire construction/properties, vehicle operational characteristics, and runway condition must be considered in the development of the tire-wear model. Phase I must provide a preliminary tire-tread-wear prediction technique with some validation based on limited data. In Phase II, experimental techniques will be developed, laboratory tests will be conducted, the tire-wear-prediction technique will be fully validated, and model parameters will be adjusted to achieve better model-to-test data correlation.

AF91-198 TITLE: Development of Improved Carbon-Carbon to Carbon-Carbon Joints

OBJECTIVE: Improve the structural properties of high temperature, bonded or brazed carbon-carbon to carbon-carbon joints.

DESCRIPTION: In order to meet its performance goals, the NASP will require complex, built-up structures fabricated from structurally efficient, refractory materials. Carbon-carbon is a leading candidate because of its high strength-to-weight and stiffness-to-weight property ratios at elevated temperatures. In addition to material availability, however, attainment of required structural weight fractions will require structurally efficient joining methods. Area joining is particularly attractive since it can offer weight advantages over fastened or bolted joints. Brazing and bonding of carbon-carbon to carbon-carbon have been investigated, but joint properties have not been uniformly acceptable or reproducible. Phase I will investigate and establish the feasibility of methods to improve the mechanical properties of high-temperature, brazed or bonded, carbon-carbon to carbon-carbon joints. As a part of Phase I, a clear understanding and familiarity with the technical issues must be demonstrated. Phase II will address processing and scale-up issues, establish characteristic mechanical properties for both static and cyclic load situations, and culminate in a small component demonstration of the selected joining method.

AF91-199 TITLE: Methods for Joining Refractory Composites to Dissimilar Materials

OBJECTIVE: Join hot, non-metallic, refractory composites to other, dissimilar material components for the NASP engine and airframe.

DESCRIPTION: Advanced, structurally efficient joining methods are required in regions of the NASP where hot, non-metallic, refractory composites, such as carbon-carbon and ceramic composites, transition to dissimilar material components. Because of differences in thermal expansion coefficients between the constituent materials and the likely presence of severe thermal gradients through the joint regions, the normal mechanical stresses are exacerbated by potentially severe thermal stresses. These joints, then, must be capable of sustaining the combined operating stresses over multiple mission cycles. Phase I will establish the technical feasibility of candidate joining methods. To do this, a clear understanding and familiarity with the technical issues must be demonstrated. Limited, small-specimen, mechanical testing should be performed to aid in assessing feasibility. Phase II will require establishing the parameters of the joining processes, scaling-up of the joining methods, and generation of characteristic test data to verify structural integrity over required lifetimes.

AF91-200 TITLE: Diagnostic Measurements of Supersonic Flow Fields

OBJECTIVE: Develop techniques for mapping scramjet flow fields with fuel penetration and mixing.

DESCRIPTION: Obtaining accurate measurements of the various flow parameters - velocity, temperature, density (or pressure), and species concentrations - in a scramjet test-cell environment without disturbing that which is measured is a formidable task. Flow field mapping is important to the understanding of fuel penetration, mixing, and combustion and to the validation of computational fluid dynamics (CFD) models. Measurements of recombination in the exhaust nozzle and of skin friction and heat transfer on all surfaces likewise will further understanding. Electronic processing of the instrumentation signals is an integral part of any mapping technique. The objective of the Phase I program will be to demonstrate the feasibility of the measurement method in a shock tunnel or blow-down tunnel. In Phase II, the contractor will develop the concept so that it can be used in a production mode in a test cell. It must tolerate high temperatures, high levels of vibration, and extended periods of continuous operation while requiring a minimum of recalibration and maintenance. Phase III would see the concept applied to scramjet combustor development programs.

AF91-201 TITLE: Optical Communications Window for Hypervelocity Vehicles

OBJECTIVE: Test procedure to evaluate optical windows for communications at hypersonic speeds.

DESCRIPTION: Hypervelocity vehicles (HVVs) will operate at high altitudes and at speeds above Mach 4 for extended periods. These conditions exert extreme stresses, e.g. plasmas, shock waves, and high temperatures and pressures, on the airframe. Proposed missions include long range reconnaissance using synthetic aperture radar and electro-optical sensors. Flying at high speeds, the HVV will be able to collect data at very high rates and will need a high bandwidth data link, e.g., a laser link to a satellite, which then relays the information to the ground. In order to support laser communications and the electro-optical sensors on board an HVV, an optical window must be developed. The window must be able to withstand the external stresses of hypervelocity flight, be transparent to the optical signals, and cause a minimum of distortion and attenuation. During Phase I, the contractor will formulate a test procedure to evaluate candidate designs for an optical communications window for HVVs. The project must consider the anticipated operating environment and the optical wavelengths and data rates required. The contractor will analyze how the candidate windows distort the beam intensity, phase front, and direction. Since the external environment varies greatly over the surface of the aircraft, the window shape and location must be considered. In Phase II, the contractor will design, fabricate, and test at least three different window designs in a representative environment. The final report will discuss the results of the tests and make recommendations for further work.

AF91-202 TITLE: Molecular Computing for Aerospace Applications

OBJECTIVE: Explore the feasibility of molecule-scale computers in the aerospace environment.

DESCRIPTION: Research at Johns Hopkins University and at Wayne State University indicates that organic "chips" which function chemically instead of electrically could potentially be made into computers ten thousand times faster than current mainframes at less than one tenth the cost. If such a computer could survive, the wide range of pressures and temperatures of a NASP-type environment, its advantages would extend beyond the obvious savings in cost and weight. Extensive monitoring of the vehicle structure might, for instance, be feasible. Phase I research will explore the environmental limits of molecular computers and their potential will design a molecular computer for a selected aerospace application so that in Phase III he can build a prototype.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out DARPA's SBIR Program rests with the Office of the Comptroller. The DARPA Coordinator for SBIR is Dr. Bud Durand. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/COMPT/SBIR
Attention: Dr. Bud Durand
1400 Wilson Boulevard
Arlington, VA 22209-2308
(703) 527-0666

The proposals will be processed in the Office of the Comptroller and distributed to the appropriate technical office for evaluation and action.

DARPA has identified 83 technical topics, numbered DARPA 91-001 through DARPA 91-083, to which small business may respond in this the first fiscal year (FY) 1991 solicitation (91.1). Please note that these are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from DARPA technical offices.

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military applicability as the budget and other factors will allow. In the early years of the SBIR program most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. DARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II limit has been lowered to $250,000.

DARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposals in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and can only respond to one topic.

DARPA has prepared a checklist to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or handcarrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

DARPA 1991 Phase I SBIR

Check List

1) Proposal Format

   a. Cover Sheet - Apendix A (identify topic number) ____
   b. Project Summary - Appendix B ____
   c. Identification and Significance of Problem or Opportunity ____
   d. Phase I Technical Objectives ____
   e. Phase I Work Plan ____
   f. Related Work ____
   g. Relationship with Future Research and Development ____
   h. Post Potential Applications ____
   i. Key Personnel ____
   j. Facilities/Equipment ____
   k. Consultants ____
   l. Prior, Current or Pending Support ____
   m. Cost Proposal ____

2) Bindings

   a. Staple proposals in upper left hand corner. ____
   b. <u>Do not</u> use a cover. ____
   c. <u>Do not</u> use special bindings. ____

3) Page Limitation

   a. Total for each proposal 25 pages inclusive of cost proposal (Appendix C) and resumes. ____
   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ____

4) Submission Requirement

   a. For DARPA you must submit 4 copies plus the original signature **RED** copy (total 5) for each proposal to be considered. ____
   b. In addition you must submit two copies of Appendix A and Appendix B only, for each proposal submission. ____

KEYWORD | TOPIC NO.

TOPIC TITLES

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

FY 1991 Small Business Innovation Research Topics

DARPA 91-001	Innovative Detection and Targeting Sensors for Camouflaged, Low Observable and Low Radar Cross Section Ground Targets
DARPA 91-002	Innovative Applications of Acoustic Charge Transport Signal Microprocessor Technology
DARPA 91-003	Low-Cost, Distributed Simulation of Logistics for the Interoperability of Defense System Simulations
DARPA 91-004	High Sensitivity Magnetic Sensors for Remote Detection of Ground Vehicles
DARPA 91-005	Flexible, Deformable Surfaces Formed from Arrays of Sub-Millimeter Sized, Linear Electromechanical Actuators
DARPA 91-006	Survivability Enhancement Technology for the Light Infantry Foot Soldier
DARPA 91-007	Novel Configurations of Electromagnetic Linear Accelerators with High Electrical Efficiency
DARPA 91-008	High Power, High Energy Density Electrical Storage Devices to Provide Pulse-Power for Electric Weapons
DARPA 91-009	Miniaturized, Integrated Guidance and Control Unit for Projectiles
DARPA 91-010	Innovative and Novel Means of Attacking and Disabling Tactical Armored Vehicles
DARPA 91-011	Low Cost Semi-Active Guidance Systems for 40 mm Rifle Grenades
DARPA 91-012	Advanced Diagnostics for Characterization of Projectile Aerodynamic Orientation
DARPA 91-013	Advanced Materials for Anti-Armor Applications
DARPA 91-014	Arms Control Registration without Physical Tags
DARPA 91-015	Three-Component, 3-Dimentional Graphical Seismic Event Location
DARPA 91-016	Coupling in Jointed Media
DARPA 91-017	Seismic Discriminants for Eurasia
DARPA 91-018	Automatic Image Scanning for Quarries, Mining, Drilling, and Craters
DARPA 91-019	Advanced Microwave and Millimeter Wave Devices and Circuits
DARPA 91-020	Innovative Packaging Techniques and Package Models
DARPA 91-021	Computer Aided Design and Process Models for Microwave and Millimeter Wave Devices and Circuits
DARPA 91-022	Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques
DARPA 91-023	Receiver Protection Technology for Microwave/Millimeter Wave Monolithic Integrated Circuits
DARPA 91-024	Non-Destructive Material Evaluation to Determine Structural Defects and Predict Reliability

DARPA 91-025	Multiple Sensors to Control Chemical Deposition Processes and Plasma Etching of Semiconductors
DARPA 91-026	Designs for Multi-Spectral Infrared Imaging Systems
DARPA 91-027	Integrated Technology Computer Aided Design
DARPA 91-028	High Speed Sensing Techniques to Determine the Surface Profiles of Materials and Components for Electronic Packaging
DARPA 91-029	Infrared Focal Plane Design, with On-Focal Plane Signal Processing for Multiple System Applications
DARPA 91-030	In-Situ Sensing and Controlling of High Temperature Manufacturing Processes
DARPA 91-031	Software Development Tools for Computer Integrated Manufacturing Systems
DARPA 91-032	Designs and Concepts for High Performance Uncooled Infrared Imaging Sensors
DARPA 91-033	Novel Materials for X-Ray Lithography Masks
DARPA 91-034	Development of a Substitute for Highly Toxic Arsine Gas for use in Fabrication of Gallium Arsenide Material
DARPA 91-035	Code Development Tools and/or Assistants for Parallel Computers
DARPA 91-036	Compiler Technology for Scalable Parallel Computers
DARPA 91-037	Graphically Based Debugging Technology for Scalable Parallel Computers
DARPA 91-038	Scalable Algorithms and Software Library Modules for Scalable Parallel Computers
DARPA 91-039	Performance Analysis and Performance Tuning Tools for Scalable Parallel Computers
DARPA 91-040	Design and Construction of Image Content-Addressable Databases
DARPA 91-041	Large Knowledge-Based System Benchmarks
DARPA 91-042	Standards for Interoperable Knowledge-Based Systems
DARPA 91-043	Tools to Support Building and Maintaining Shared Ontologies
DARPA 91-044	Evaluation Methods and Metrics for Image Processing and Understanding Algorithms
DARPA 91-045	Software Reverse Engineering Tools for Inclusion in Open Architecture Environments
DARPA 91-046	Application of Image Understanding Techniques to Underwater Acoustic Analysis
DARPA 91-047	Open Architecture Hypertext and Group Coordination Support for Advanced Software Design Environments
DARPA 91-048	Software Design Documentation Record Structural Design
DARPA 91-049	Robust Fusion of Multi-Spectral and Multi-Temporal Images
DARPA 91-050	Modular Open Architecture Intelligent Controllers for General Purpose Machine Tools
DARPA 91-051	Improvements to Peripheral Security of Timeshare Systems

DARPA 91-052	Computer Supported Cooperative Work Software Architecture Design for Mechanical Design and Analysis
DARPA 91-053	Design Documentation Record Architecture in Mechanical Computer Aided Design Environment
DARPA 91-054	Integration of Multi-Spectral Sensors in Modular, Open Architecture Controllers for Precision Control of Metal Cutting Machinery
DARPA 91-055	Novel Applications of Superconductor Technologies to Satellites
DARPA 91-056	Shape Memory Alloy Material Development for Actuators
DARPA 91-057	In-Situ Vorticity Measurement System
DARPA 91-058	Innovative Underwater Launch Concept for an Endurance Unmanned Aerial Vehicle
DARPA 91-059	Multi-Sensor Management Techniques for a High Altitude, Long Endurance Unmanned Aerial Vehicle
DARPA 91-060	New Approaches to Long Wavelength Infrared Imaging Devices
DARPA 91-061	Diode Pumped Upconversion Lasers in the Blue-Green Wavelength Region
DARPA 91-062	Organic, Nonlinear Materials for Wavelength Conversion
DARPA 91-063	Multi-Frequency Laser Materials
DARPA 91-064	Using Diode Lasers for Compact Eye-Safe Laser Radar
DARPA 91-065	Detection and Analysis of Random-Pulse Ultra-Wide Band Signals
DARPA 91-066	Low Temperature Diamond Film Deposition for Thermal Management
DARPA 91-067	Advanced On-Line Sensor for Materials Manufacturing, Process Control, and Quality Assurance
DARPA 91-068	Applications of Data Fusion to Signal Processing
DARPA 91-069	Intelligent Control Related to Materials Manufacturing
DARPA 91-070	Novel Concepts for Processing Structural Ceramic Composites
DARPA 91-071	Processing of Molybdenum Disilicide ($MoSi_2$) Matrix Composites
DARPA 91-072	Development of CO_2 Rejecting Electrolytes for Fuel Cells
DARPA 91-073	Super Acid, Solid Electrolyte Catalysts for Fuel Cells with Direct Oxidation of Hydrocarbon Fuels
DARPA 91-074	Fuel Cell Catalysts for Direct Oxidation of Methanol
DARPA 91-075	Assessment of Materials, Structures, and Component Development Using Advanced Combat Models
DARPA 91-076	Application of High Temperature Superconductors to Electronic Circuitry
DARPA 91-077	Thin Film, High Dielectric Constant, Micron Sized Capacitor Materials

DARPA 91-078	Neural Net Applications Leading to Hardware Implementation
DARPA 91-079	Device Phenomena Unique to Sub-Micrometer Devices
DARPA 91-080	Integrated Spatial Light Modulators for Optical Processing with Incoherent Light
DARPA 91-081	Reproducible Growth Techniques for Ultra Thin Epitaxial Multilayers on III-V Substrates
DARPA 91-082	Chemical, Biological Warfare Treaty Verification
DARPA 91-083	Advanced Military Medicine

DEFENSE ADVANCED RESEARCH PROJECTS

FY 1991 Topic Descriptions

DARPA 91-001 TITLE: Innovative Detection and Targeting Sensors for Camouflaged, Low Radar Cross Section Ground Targets

CATEGORY: Exploratory Development

OBJECTIVE: To demonstrate innovative sensors for the detection and targeting of reduced-signature ground vehicles.

DESCRIPTION: DARPA is investigating advanced technologies for detecting and targeting next generation ground vehicles which seek to achieve survivability by hiding in dense cover and employing deception and denial techniques. Current technology used to reduce the detectability of ground vehicles includes such techniques as the use of camouflage netting, both visible/infrared (IR), and radar scattering. Next generation ground vehicles can be expected to employ even more advanced techniques to further reduce their detectable signatures. DARPA is interested in innovative sensor and processing technologies to detect, classify and target these next generation ground vehicles. Possible approaches could include use of unusual regions of the electromagnetic spectrum, unique signature phenomenology differentiating manmade and natural objects, innovative combinations of sensors, and innovative signal processing techniques. Strong emphasis will be placed on truly innovative concepts that offer the potential for significant improvement in capability, even if there is technological risk. Proposals must include a discussion of how the technology would be operationally useful.

Phase I: Provide detailed analysis of the proposed detection sensor technique based on physical principles as well as an analytical assessment of available experimental data. Include a prediction of the increase in operational capability as a result of the technique (e.g. improved detection range, increased probability of detection, reduction in false alarm rates, etc.)

Phase II: Develop laboratory demonstrations to verify the technical approach.

DARPA 91-002 TITLE: Innovative Applications of Acoustic Charge Transport Signal Microprocessor Technology

CATEGORY: Advanced Development

OBJECTIVE: The objective of this project is to demonstrate significant enhancements in a military electronics system application through the use of an acoustic charge transport (ACT)-based signal microprocessor.

DESCRIPTION: ACT technology has evolved in recent years from a basic research activity, through the demonstration of a variety of specific devices, to the currently available "signal microprocessor." The "signal microprocessor" is a high capability, digitally programmable, integrated circuit which can process analog signals by mathematical computation, thereby providing the same type of functionality for analog signals as the traditional microprocessor does for digital data. Such a device combines analog processing speeds and simplicity with the programmable versatility traditionally attributed only to digital processing techniques. Indeed, the signal microprocessor can be implemented all-digitally as an integrated circuit surrounded by convertors, but even the currently available ACT-based microprocessor is 1,000 times faster than any available digital version and can operate on signals in the video, IF, and RF frequencies while digital versions operate only at audio frequencies.

Functionally, the ACT-based microprocessor can be represented as a digitally programmable transversal filter. A standardized unit provides 128 taps, currently available 6-bit tap weight accuracy, and 150 MHz bandwidth. The unit requires only external DC power and a standard PC printer interface for control. The hardware is supported by a user friendly software package which automatically and dynamically controls tap weights in response to user objectives, specified in a wide variety of ways. Units can be stacked for greater accuracy or cascaded for more taps/delay lengths. It is clear that such a device presents a powerful capability that has application in a variety of military electronic systems. It is the intent of this topic to identify and demonstrate such applications.

Phase I: Identify a promising application of an ACT-based signal microprocessor which would enhance an existing military electronic system concept or allow for the development of a new capability. Provide a preliminary design to theoretically demonstrate the enhanced capability. While the concept may be demonstrated in this design study, the use of laboratory experiments for demonstrating feasibility at some level, or investigating critical technical issues is not excluded.

Phase II: Build a feasibility demonstration model of the system concept and demonstrate its performance.

DARPA 91-003 TITLE: Low-Cost, Distributed Simulation of Logistics for the Interoperability of Defense System Simulations

CATEGORY: Exploratory Development

OBJECTIVE: To explore and implement concepts for realistically portraying the effects of logistics in the distributed simulation of combined arms warfare (i.e., personnel replacement, resupply, and maintenance.)

DESCRIPTION: The modeling of logistics in the distributed simulation of a combined arms battle is generally of a lower fidelity than the modeling of the combat arms. It is recognized that logistics constraints affect the tempo of the battle; however, as it is currently implemented, the logistics model is incomplete. It only approximates the delays introduced by resupply, replacement and maintenance, and it does not realistically task combat service support personnel in their wartime duties. As a result, the training received by the support staff is degraded, and the credibility of the simulation suffers.

Phase I: Prepare concepts for the realistic modeling of logistics, and concepts for how that model might be implemented at a workstation(s) as part of a larger network of simulators.

Phase II: Develop, test, and validate selected concepts in a stand alone local area network for the training of support staff, and as part of an existing network of simulators for the simulation of a combined arms battle.

DARPA 91-004 TITLE: High Sensitivity Magnetic Sensors for Remote Detection of Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system of sensors capable of detecting and localizing objects of military interest using disposable distributed sensors.

DESCRIPTION: A continuous or highly distributed system of low cost magnetic sensors is desired which is capable of detecting the approach of ground vehicles, such as trucks, or small objects, such as rifles, from distances of 50 or more meters. These sensors may be ground based or strung over trees. These devices should be capable of discriminating against magnetic noise/interference, and should be capable of localizing and, if possible, establishing a vector to the target. Transmission of sensor data to a central node need not be addressed, however, systems with inherent data transmission capabilities will be considered as advantageous.

Phase I: Define magnetic sensor system design/optimization. Calculate system effectiveness, accuracy, noise immunity, and development cost. Field demonstrations of critical parameters with objects of interest are desirable.

Phase II: Test and demonstrate a complete system in both laboratory and field environments. Develop production cost estimates for the proposed system.

DARPA 91-005 TITLE: Flexible, Deformable Surfaces Formed from Arrays of Sub-Millimeter Sized, Linear Electromechanical Actuators

CATEGORY: Exploratory Development

OBJECTIVE: To develop a two-dimensional array of interconnected, submillimeter, electromechanical devices and the processing system to precisely control exterior surface shape of a section of a scaled aircraft wing.

DESCRIPTION: Micro-machines, micro-motors, and micro-actuators have been developed which are smaller than 1.0 mm^3 in volume, extremely light, and exhibit extremely rapid response times. This project seeks to explore the feasibility of using this technology to build light, deformable aircraft surfaces which 1) enable low drag flight for various flight conditions and velocities, and 2) perform the aircraft control functions normally accomplished by wing flaps.

Phase I: Develop an innovative concept for appropriate individual electromechanical devices, a concept for connecting devices into an array, and a concept for a processing/control system. Investigate resulting system concept(s) to determine advantages and disadvantages of concept for the intended application.

Phase II: Construct and test a proof-of-principle demonstrator.

DARPA 91-006 TITLE: Survivability Enhancement Technology for the Light Infantry Foot Soldier

CATEGORY: Exploratory Development

OBJECTIVE: To provide significant improvements in the survivability of the individual foot soldier against opposing forces, particularly in low intensity situations with difficult terrain such as jungles or mountains.

DESCRIPTION: Individual soldier survivability may be enhanced by better protection, reduced visual signature, greater mobility, greater firepower, improved communications, improved ability to detect and aim at enemy soldiers, an ability to rapidly and accurately cue heavier arms, and many other methods. Proposed concepts should be capable of providing a significant payoff and should impose minimal burden on the soldier.

Phase I: Define survivability system design/optimization. Provide a complete assessment of the technical performance and the required technical development, as well as an assessment of the operational payoff and cost versus other known approaches. It is desired that key technologies or components be demonstrated.

Phase II: Test and demonstrate a complete system in the laboratory and the field. Develop production cost estimates for the proposed system.

DARPA 91-007 TITLE: Novel Configurations of Electromagnetic Linear Accelerators with High Electrical Efficiency

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for electromagnetic launcher components.

DESCRIPTION: Concepts are sought for novel configurations of electromagnetic linear accelerators for gun and launch applications. The emphasis should be on high electrical efficiency and the absence of high current arcs, current collection brushes and mechanical commutation.

Phase I: Provide a detailed definition of the proposed concepts followed by an optimized design and performance analysis of proof-of-principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test the proposed proof-of-principle hardware.

DARPA 91-008 TITLE: High Power, High Energy Density Electrical Storage Devices to Provide Pulse-Power for Electric Weapons

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches and configurations for high power, high energy density electrical storage devices to provide pulse-power for electric weapons.

DESCRIPTION: Concepts are sought for novel configurations for storage and pulse forming power supplies. The emphasis should be on device goals: energy densities in excess of 15 kJ/kg and power densities of 100 to 1000 kw/kg.

Phase I: Provide a detailed definition of the proposed concepts followed by an optimized design and performance analysis of proof-of-principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test the proposed demonstration hardware.

DARPA 91-009 TITLE: Miniaturized, Integrated Guidance and Control Unit for Projectiles

CATEGORY: Exploratory Development

OBJECTIVE: To explore alternative approaches to guidance and control of tactile projectiles.

DESCRIPTION: Novel guidance and control concepts are sought to improve the accuracy of extended range, direct-and indirect-fired projectiles. Concepts of interest would include novel aeroballistic control devices and inertial or command guidance components. The emphasis should be on simple, miniature, low cost concepts which would be compatible with high acceleration launch from hypervelocity guns.

Phase I: Provide a detailed design of the proposed concepts followed by an optimized design and performance analysis of proof-of-principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test proof-of-principle hardware.

DARPA 91-010 TITLE: Innovative and Novel Means of Attacking and Disabling Tactical Armored Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To explore new and innovative means of defeating armored vehicles other than massive disruption of armor.

DESCRIPTION: Concepts are sought for innovative and novel means of attacking target armored vehicles by reducing or eliminating effectiveness of vehicle firepower, mobility, armor, and crew capability, and/or rendering them vulnerable to further attack. Technologies which can disrupt the tempo of operations, command and control, and target acquisition, degrade the ability of follow-on forces, or interrupt logistics, can also be considered.

Technologies which would support anti-drug or anti-terrorist operations are also of interest. Concepts for penetration of heavy armor are not of interest in this request.

Phase I: Provide a detailed definition of the proposed concepts followed by an optimized design and performance analysis of proof-of-principle hardware. Some subcomponent development may be appropriate.

Phase II: Construct and test the proposed demonstration hardware.

DARPA 91-011 TITLE: Low Cost Semi-Active Guidance Systems for 40mm Rifle Grenades

CATEGORY: Advanced Development

OBJECTIVE: To develop a system allowing an individual foot soldier to accurately aim 40mm low velocity grenades in order to

shoot into small openings in bunkers or entrenched areas.

DESCRIPTION: A rifle-mounted designator or other guidance device is desired to provide greatly enhanced accuracy (e.g., +/-6 inches or better) to a round aimed within 1 to 2 degrees of target. The round should be compatible with the current 40mm launcher and should provide a similar lethal effect, but should use the guidance device signal to achieve significantly improved accuracy. Cost of the round will be a significant factor.

Phase I: Provide detailed system design. Thoroughly analyze technical performance and develop production cost. It is desired that key components be demonstrated if possible.

Phase II: Fabricate and demonstrate all key subsystems. If possible, a complete system (without fuze and explosive) shall be demonstrated. Production cost estimates shall be refined.

DARPA 91-012 TITLE: Advanced Diagnostics for Characterization of Projectile Aerodynamic Orientation

CATEGORY: Advanced Development

OBJECTIVE: To develop and demonstrate a diagnostic system able to characterize the instantaneous location and orientation of a kinetic energy projectile with a resolution of one millimeter or less at an instant in time.

DESCRIPTION: Pitch and yaw at the moment of launch and impact, as well as in flight, are important parameters when characterizing the ballistic performance of a kinetic energy projectile. The orientation becomes even more crucial as projectiles get longer and thinner. Even if the pitch and yaw cannot be precisely controlled, one may characterize the performance much more accurately if the orientation is known. Presently, the best way to get information on projectile orientation is through the use of orthogonal X-ray stations. This procedure can be laborious, clumsy, and slow. Additionally, most test facilities are limited in the number of X-rays they can use. A system is needed that can characterize the flight of a projectile over an extended range without influencing that flight. Data should be available with a quick turn around and an interface should be available to record the data electronically.

Phase I: Provide an innovative, detailed design which can provide a proof-of-concept demonstration of each candidate system.

Phase II: Develop and fabricate a "breadboard" system which could prove the concept with actual hardware.

DARPA 91-013 TITLE: Advanced Materials for Anti-Armor Applications

CATEGORY: Advanced Development

OBJECTIVE: To utilize innovative fabrication techniques to produce aeroshells, sabots or other projectile support structures from lightweight, high modulus composite materials.

DESCRIPTION: Lightweight, high modulus, composite materials (such as graphite or boron fibers with a matrix of epoxy resin) should be ideal for use as structural elements (i.e., aeroshells or sabots) in kinetic energy projectiles. The structures must be capable of accepting high dynamic loads (80 to 100 kilogees) without failure and transferring those loads to kinetic energy projectiles. Any mass savings can be directly converted to higher velocity or more mass in the projectile. However, the lack of consistency in properties and fabrication techniques has limited the application of these materials. Innovative concepts for utilizing these types of materials, along with the proof of the fabrication methods, would help to extend the use of composites and improve the performance of kinetic energy projectiles.

Phase I: Develop fabrication techniques for selected composite materials to meet desired performance goals.

Phase II: Demonstrate fabrication technique and perform static and dynamic test of fabricated composite structures.

DARPA 91-014 TITLE: Arms Control Registration without Physical Tags

CATEGORY: Basic Research

OBJECTIVE: Develop methods for registration, inventory, and tracking of arms control treaty-related items without use of attached physical tags.

DESCRIPTION: Partners to a treaty could periodically send each other non-invertible encrypted (hashed) lists of the locations and individual identities of all treaty-limited items (TLI). At some later time, hours or months, all or portions of these lists could be made clear, either routinely or in response to a challenge; and the open hashing algorithm could be used to authenticate the cleared lists. A challenge could, for example, ask for a demonstration of the hashing of the entry to show the TLI closest to a specific location at a specific time some months past. To the degree that the movement of the TLI were random, no information about current locations would be revealed by this procedure. In conjunction with other inspection techniques, such a procedure

could possibly enable at least probabilistic tracking of TLI from factory to destruction.

Phase I: Conduct an operations research analysis of the registration and tracking of TLI by use of hashed lists. Discuss the types of equipment which could be controlled, degrees of control, cooperative use with other inspection techniques, methods for creation and transmission of the lists, frequency with which the lists are updated, optimum strategy for both sides to the treaty, possible cooperative use of physical tags, security aspects of the problem assuming the existence of non-invertible encryption functions, how evasive substitutions of warehouse for field TLI could be controlled, other possible evasion topics, and other topics which are considered to be relevant.

Phase II: Design a detailed application of current interest. Discuss the required hardware and software, and design a demonstration project.

DARPA 91-015 TITLE: Three-Component, 3-Dimensional, Graphical Seismic Event Location

CATEGORY: Engineering Development

OBJECTIVE: Design and develop interactive 3-Dimensional graphical techniques for display of 3-component seismic data to enhance determination of the station event azimuth and emergence angle.

DESCRIPTION: There is extensive literature on the use of automatic, non-linear techniques to determine the back azimuth and emergence angle of seismic signals recorded at a single 3-component station at teleseismic and regional distances. Routine analyst practice from the earliest days of seismology has determined back azimuth from the inverse tangent function applied to the ratio of first motion amplitudes on horizontal components. This project should provide the analyst with a computer interface to enable him to fluidly use as much of the signal as possible, both in time and frequency, to determine back azimuth and emergence angle. The project should also enable the analyst to selectively weight time and frequency and to force solutions using mathematical solutions only as guides.

Phase I: Design a prototype graphical interactive processor for 3-component seismic data at teleseismic and regional distances. Demonstrate the prototype on actual data. The prototype is to use X-Windows and other software standards of the Nuclear Monitoring Research Development (NMRD) systems to ensure final compatibility with those systems.

Phase II: Train a seismic analyst to use the system developed in Phase I, and have him or her exercise it on extensive data from Eurasian events in bulletins determined by the NMRD systems. Improve the system, both in capability, friendliness, and speed in response to comments from the analyst. Develop new processors and analyst procedures to achieve better agreement between true and calculated azimuths. Compare to automatically determined azimuths.

DARPA 91-016 TITLE: Coupling in Jointed Media

CATEGORY: Basic Research

OBJECTIVE: Perform laboratory experiments to directly investigate the effect of rock joints on the seismic coupling of explosions.

DESCRIPTION: The role that rock joints play in the coupling of seismic waves from nuclear explosions is a subject of controversy. It is generally agreed that since rocks are weakened by joints, the coupling must be increased. However, there are no theories which quantify this increase without an unacceptable number of free parameters. The object of this study is to perform laboratory experiments to provide basic data for analysis, and perhaps to give direct experimental insight into the size of the effect of joints.

Phase I: Design a set of laboratory experiment to determine the relative coupling of intact and jointed rock (perhaps simulated by cutting up the intact rock into small cubes and re-assembling) in dry and saturated conditions under confining stresses typical of burial at depths of 300-600 meters. If possible obtain some initial experimental results. Discuss methods of analysis of the data and the extrapolation to nuclear scales.

Phase II: Carry out the complete set of experiments designed in Phase I. Discuss possible field experiments with conventional explosives and perform analyses to extrapolate the results to nuclear scales.

DARPA 91-017 TITLE: Seismic Discriminants for Eurasia

CATEGORY: Basic Research

OBJECTIVE: Develop and test techniques to discriminate between quarry blasts and earthquakes using events listed in regional seismic bulletins produced at the Center for Seismic Studies (CSS).

DESCRIPTION: Monitoring of low threshold nuclear test ban treaties will depend on our ability to identify earthquakes and explosions down to magnitude mb of about 2.5. For the Soviet Union, a large database consisting of analyzed regional seismic recordings of such events is now being accumulated at the DARPA Center for Seismic Studies, and the DARPA research

program has produced a number of techniques that show some promise as discriminants for such events. DARPA has also sponsored the development of an Intelligent Monitoring System (IMS) for the automated analysis of seismic data, and this system is currently being expanded to include a framework for event identification. This project is aimed at testing known discriminants using events in the Center database, and developing and testing new discriminants on the same data. Results of the investigation will be used to design new discrimination modules for the IMS.

Phase I: Review regional discrimination techniques, including depth, in the literature. Develop a systematic discrimination procedure which allows for the existence of unidentified events in the case of discriminant overlap and in the case of insufficient data or signal to noise ratio. Discuss quality control parameters for the discriminants. Discuss step-by-step, voting, and multi-dimensional statistical decision procedures. Discuss performance of the discriminants in the presence of evasion scenarios. Define the magnitude and geographical range to be considered. Gather a prototype representative but small data base and exercise the discriminants on that data base.

Phase II: Exercise the discrimination procedure developed in Phase I on as much as possible of the analyzed data available at the CSS which fits the magnitude and geographical range defined in Phase I

DARPA 91-018 TITLE: Automatic Image Scanning for Quarries, Mining, Drilling, and Craters

CATEGORY: Engineering Development

OBJECTIVE: Develop means for automatic scanning of overhead digital images for quarry, mining, and drilling operations; and for explosion generated craters.

DESCRIPTION: Many seismically detected explosions are due to mineral development activities. The determined locations of these events are often inaccurate, with typical errors of 20 kilometers. Thus, if overhead imagery were available, it would be necessary to scan images of approximately 1600 square kilometers to find possible sources of the seismic activity to examine further. This is a substantial analytic workload to accomplish without an analyst aid or tool. It is not necessary that a totally automatic method be developed; simply an approach. For example, a scraped-earth detector and zoom capability, could provide perhaps a ten-fold or more improvement in analyst coverage speed without substantial loss of detection capability.

Phase I: Design procedures and systems to enhance detection of mineral development activities in overhead images by a factor of 10 or more over simple scanning. Perform a prototype demonstration using an overhead image.

Phase II: Develop a prototype analysis system, analyze a large data-base of overhead images and detect mineral development operations. Compare speed of analysis to routine analysis. Compare to independent lists, such as records of regulatory agencies, to discover and characterize missed detections. Determine false alarms by additional investigation of questionable detections.

DARPA 91-019 TITLE: Advanced Microwave and Millimeter Wave Devices and Circuits

CATEGORY: Advanced Development

OBJECTIVE: To advance the development and fabrication of microwave and millimeter wave devices and monolithic format circuits that will provide performance levels and satisfy system requirements that are not being adequately met.

DESCRIPTION: Gallium arsenide metal-semiconductor field effect transistors (GaAs MESFETs) are being successfully used in a wide range of microwave applications and many millimeter wave applications. However, these devices and the circuits using them have performance limitations in terms of noise, power output and efficiency, particularly at frequencies above 50 GHz. This project is directed toward the development of devices and monolithic format circuits from other material combinations (e.g. heterostructures, indium phosphide) that provide performance improvements compared to the present devices and circuits. Particular emphasis should be placed on meeting military system requirements that cannot adequately be met with existing structures.

Phase I: Select one or more devices and/or monolithic format circuits that offer the possibility of performance improvements at microwave and millimeter wave frequencies beyond the present state-of-the-art. Develop a plan for the fabrication of the device and/or circuit structures that will result in production at the lowest possible cost.

Phase II: Develop final design and fabricate prototype samples of the device and circuit structures selected for demonstration. Measure and provide report on the microwave or millimeter wave frequency performance characteristics.

DARPA 91-020 TITLE: Innovative Packaging Techniques and Package Models

CATEGORY: Advanced Development

OBJECTIVE: To advance the development and fabrication of packaging structures for digital and analog (microwave and millimeter wave) circuits that result in improved performance characteristics, packing densities and lower cost.

DESCRIPTION: Advanced multi-chip packaging structures and packaging boards containing a number of interconnected chips

offer the promise of providing improved overall system performance at a lower cost. Packaging structures for millimeter wave frequency analog devices are at an embryonic stage of development. New materials and techniques should allow improved performance characteristics at a lower unit cost than is presently possible with each chip individually packaged in a conventional structure.

Phase I: Select one or more packaging approaches for either digital circuits, millimeter wave frequency circuits or both. Develop one or more approaches for packaging these circuits in a manner that leads to improved overall performance at the lowest possible costs. Describe performance/cost tradeoffs for each approach studied.

Phase II: Develop final designs and fabricate prototype samples of the package structures selected for demonstration. Measure and report on their performance characteristics. Develop a plan for producing these packages in large quantities including a description of necessary equipment and facilities.

DARPA 91-021 TITLE: Computer Aided Design and Process Models for Microwave and Millimeter Wave Devices and Circuits

CATEGORY: Advanced Development

OBJECTIVE: To provide models for microwave and millimeter wave frequency solid-state devices and monolithic format circuits that accurately predict actual device and circuit performance over the widest possible frequency range. Emphasis should be placed upon the development of models that predict device/circuit performance from processing parameters and that operate on commercially available computer aided design software packages and workstations.

DESCRIPTION: At the present time, reasonably accurate models are available for microwave solid-state devices and circuits that operate in a linear mode within the frequency range from 1 to 20 GHz. Additional work is needed to improve the accuracy of models for operation of devices and circuits in the 20 to 100 GHz range and for operation of active devices in a non-linear (high power) mode. Devices of particular interest are metalsemiconductor field effect transistors (MESFETs), high electron mobility transistors (HEMTs) and heterojunction bipolar transistors (HBTs) fabricated from III-V compound semiconductor materials. Circuits of particular interest are in a monolithic format fabricated from gallium arsenide. Most desirable are models which can be used to tie processing parameters to circuit design parameters.

Phase I: Select one or more devices and/or circuit configurations and develop models which result in accurate prediction of device and/or circuit performance. Provide a clear indication of accuracy and needed improvements. Consideration should be given to how proposed models will extend computer aided design capabilities beyond those afforded by use of currently existing models, and to compatibility of models with existing commercially supported software packages and workstations.

Phase II: Complete model development and write appropriate software description that can be used in conjunction with commercially supported software and workstations.

DARPA 91-022 TITLE: Computer Analysis of New Microwave Devices and/or Monolithic Circuit Techniques

CATEGORY: Advanced Development

OBJECTIVE: To provide computer aided design methods to accurately analyze the predicted performance of new analog device and/or monolithic format circuit structures intended for operation in the 1 to 100 GHz frequency range.

DESCRIPTION: A number of recent device structures have been proposed which may result in superior transmitter and/or receiver performance at microwave and millimeter wave frequencies. In some cases, the basic device structure is not new but the material structure proposed for device fabrication is; in other cases completely new device structures are under consideration. Similarly, new circuit designs are under consideration that result in performance advantages such as broader-band operation, higher efficiency operation or higher power outputs. This project will result in the development of computer aided design techniques and models that can be used to analyze the performance and advantages of new devices and monolithic format circuits in microwave and millimeter wave systems.

Phase I: Select one or more promising microwave and/or millimeter wave device and/or monolithic format circuit structures for model development. Provide a proposed model with a clear indication of accuracy and needed improvements.

Phase II: Complete modeling and computer aided design software with emphasis upon accuracy and compatibility with existing commercially available computer aided design software and workstations.

DARPA 91-023 TITLE: Receiver Protection Technology for Microwave/Millimeter Wave Monolithic Integrated Circuits

CATEGORY: Advanced Development

OBJECTIVE: To develop novel, low cost, practical methods for protecting microwave/millimeter wave monolithic integrated circuits (MIMICs) from damage caused by pulsed electromagnetic radiation (EMP) from friendly or hostile sources.

DESCRIPTION: MIMIC circuits afford excellent performance characteristics at low cost and with high reliability for numerous

DoD applications. For some of these applications (e. g. shipboard radar systems), the MIMICs must be placed in close proximity to high power microwave sources. In other situations, radiation from hostile sources (e. g. jammers) is used to disable microwave/millimeter wave equipment and components. Protection for most circuits is provided by so-called T/R switches. However, these switches cannot always respond quickly enough to high power, short pulse inputs. This project is directed toward providing additional protection for MIMIC circuits against damage from high power, short pulse radiation, including, the use of a portion of the MIMIC chip to provide the protection. If so, the impact on the cost, processing, yield and performance of the MIMIC chip must be minimal.

Phase I: Select one or more promising approaches to providing the needed circuit protection. Identify impact on cost of the overall system, size, weight and power supply requirements and whether or not any portion of the MIMIC chip itself will be used to provide the protection.

Phase II: Demonstrate the usefulness of the proposed approach by building the proposed protection circuitry and demonstrating its ability to protect one or more classes of MIMIC circuits without imposing unreasonable cost increases or size, weight and power supply increases.

DARPA 91-024 TITLE: Non-destructive Material Evaluation to Determine Structural Defects and Predict Reliability

CATEGORY: Advanced Development

OBJECTIVE: Development of in-process sensor technology and test methodology for non-destructive, real-time evaluation of material structural properties during manufacturing.

DESCRIPTION: Manufacturing requires the real-time evaluation of materials, both metals and semiconductor crystals, to determine structural properties, including an inspection for latent defects. Current evaluation techniques usually require contact with the material during testing and often require extensive set-up and evaluation time. For example, X-ray, ultrasonic and optical characterization have proven effective, but require off-line evaluations that utilize special facilities and increase cost. Feedback to manufacturing can be slow, resulting in additional cost. The establishment of real-time, on-line evaluation of material properties as an in-process control, integral to the manufacturing operation, would provide a more effective means of reducing manufacturing cost and improving product quality. The non-destructive evaluation techniques should apply to either compound semiconductors, composites, or electronic materials.

Phase I: Determine the feasibility of non-destructive evaluation techniques and correlate the results of these techniques to the results of conventional approaches. Select and evaluate material samples from a representative defense manufacturing process and identify material defects that are related to failure modes. Establish material evaluation criterion for qualifying the material for a product application.

Phase II: Demonstrate the cost reduction, and increases in yield and throughput of a manufacturing line in defense manufacturing after application of selected evaluation techniques.

DARPA 91-025 TITLE: Multiple Sensors to Control Chemical Deposition Processes and Plasma Etching of Semiconductors

CATEGORY: Advanced Development

OBJECTIVE: Development of sensor technology, with associated signal processing, for real-time control of the process variables affecting chemical deposition and etching of semiconductors.

DESCRIPTION: Chemical vapor deposition and plasma etching of semiconductors are complex manufacturing processes, requiring the control of multiple parameters to insure the repeatability and quality of the process. Currently, control parameters, such as pressure, temperature and gas flow rates, are set externally to the reactor and are monitored independently to ensure the stability of preset parameters. Conditions within the reactor, where the material is actually processed, are not directly monitored. Also, sensors within the reactor function independently, without detailed information from other sensors within the reactor. Sensors-based control could be significantly improved with a suite of synergistic sensors. Data from the multiple sensors could be integrated into a processor, guided by an analytical/empirical model, to ensure the process is following the prescribed optimum process.

Phase I: Select the process control variables using a process model as a guide. Evaluate sensor concepts, with the appropriate signal processor, to determine the optimum sensor/processor combination. Demonstrate the fusion of process control data from multiple sensors in a prototype reactor.

Phase II: Demonstrate an improved chemical deposition or etching process using the sensor suite integrated into a production compatible reactor. Demonstrate material quality and yield improvements relative to processing without the use of the sensor control.

DARPA 91-026 TITLE: Designs for Multi-Spectral Infrared Imaging Systems

CATEGORY: Advanced Development

OBJECTIVE: Formulate and evaluate the design of an infrared focal plane array, with the associated signal processor, to detect radiation in multiple bands within the 1-14 micrometer infrared spectral region.

DESCRIPTION: Infrared focal plane arrays can be made sensitive to radiation within abroad spectral band. This can be accomplished with a single material or with different materials sensitive to specific infrared bands. The organization of the focal plane for detection of the multiple bands and the signal processing associated with the detection of radiation in multiple bands must be developed.

Phase I: Develop a design of a multi-spectral infrared sensor. Evaluate the design with performance modeling of both the detector and the signal processor. Evaluate improved system performance under various atmospheric conditions and target scenarios.

Phase II: Evaluate the producibility of multi-spectral infrared focal plane designs. Assess material growth constraints and signal processing capabilities relative to the current capabilities. Fabricate signal processor chip designs and perform a laboratory evaluation to verify the performance predictions.

DARPA 91-027 TITLE: Integrated Technology Computer Aided Design

CATEGORY: Advanced Development

OBJECTIVE: Develop novel approaches to reduce the cost, speed the testing, and accelerate the deployment of integrated Technology Computer Aided Design (TCAD) systems.

DESCRIPTION: The development of new semiconductor manufacturing technologies is a multi-disciplinary task. Engineers consider electrical, mechanical, thermal, and chemical properties as they develop a device architecture to meet a product requirement and develop the process to fabricate that architecture. This means using software tools which were developed by a number of different individuals and companies, run on different platforms, and use proprietary data structures. Examples of TCAD tools include electrical circuit and device simulators, physical layout tools, process (deposition, etch, implant, etc.) simulation tools, thermal and reliability analysis, and yield estimators. The use of a common support infrastructure or "framework" has been proposed as a way to simplify the integration of those tools into a productive environment. The framework should support the use of industry standard data models and provide uniform access to services such as data management, tool invocation, communications, user interface, and operating system. Such frameworks have already been successfully demonstrated for integrated circuit design environments, but have yet to be applied to TCAD even though many of the requirements are the same.

Phase I: Define a detailed set of requirements for a TCAD framework. Evaluate existing framework technology and emerging industry standards for applicability to TCAD. Propose an approach to extending that technology into the TCAD arena and a demonstration of its utility for integrating TCAD tools.

Phase II: Develop the detailed functional and information models to support TCAD. Implement those models using off-the-shelf framework technology. Demonstrate the utility of the framework by integrating a number of TCAD tools from more than one commercial source into an integrated environment.

DARPA 91-028 TITLE: High Speed Sensing Techniques to Determine the Surface Profiles of Materials and Components for Electronic Packaging

CATEGORY: Advanced Development

OBJECTIVE: This project develops hardware and techniques for real-time inspection of interconnections used in densely packed integrated circuits for multi-chip electronic modules.

DESCRIPTION: As signal processing and computing functions become more complex, circuits are being implemented in multi-chip modules. Reliable interconnections on these modules are essential to the successful implementation of the processing function. Inspection of the interconnections prior to the integration of the chips into modules is essential to manufacturing the electronic package. From several hundred to one thousand interconnections will be included in a typical processing module. Real time inspection of these interconnections requires high speed signal processing to assess the spacing, alignment and, in some applications, the shape of each contact prior to the formation of the interconnection. An increase in the speed of the current inspection systems is necessary to achieve on-line evaluation of the electronic interconnections. Improvements in both the sensor array technology and the associated signal processing is necessary to implement a real time high speed inspection for electronic packages.

Phase I: Assess the various methods of achieving the speed required for real time inspection of interconnections for electronic packages. Evaluate the preferred approach in a laboratory breadboard before the completion of the first phase. Identify design trade-offs considering the sensor array, processing function, the speed and accuracy required for real time inspection, and the potential savings in packaging cost.

Phase II: Finalize the design and build a prototype system. Integrate the system into a manufacturing

environment for the real-time inspection of contacts for electronic packages. Document the performance of the inspection system including the accuracy, speed, cost of the operation, and the savings in packaging cost achieved through integration of the inspection system into the manufacturing line.

DARPA 91-029 TITLE: Infrared Focal Plane Design, with On-Focal Plane Signal Processing, for Multiple System Applications

CATEGORY: Advanced Development

OBJECTIVE: Design an infrared focal plane array with application to a generic family of tactical system applications.

DESCRIPTION: Infrared focal plane arrays (IRFPA) consist of a large number of individual infrared detector elements, organized in a specific configuration to meet particular system requirements. As a result, many IRFPA configurations are proposed, each with a unique detector configuration and associated signal processor design. Each of these focal plane array designs require custom drive electronics, read-out sequences and interfaces to off-focal plane electronics, which places a substantial non-recurring design and verification burden on each system application. In addition, the production quantities required of each particular design are not sufficient to achieve the cost benefits associated with volume production. A family of generic designs has the potential to achieve the production volume to substantially reduce cost.

Phase I: Design and model the performance of an IRFPA that meets multiple system requirements within a tactical mission area (e.g., missile seeker, infrared search and track, target acquisition). Evaluate the IRFPA design by modeling sensor performance using suitable parameters for the sensor system for each application. Design and model the performance of the modular drive electronics for the generic family of IRFPAs.

Phase II: Develop a breadboard demonstration of the modular drive electronics. Design and build the electronics module and demonstrate performance for a family of IRFPAs.

DARPA 91-030 TITLE: In-Situ Sensing and Controlling of High Temperature Manufacturing Processes

CATEGORY: Advanced Development

OBJECTIVE: Development of non-contact techniques to measure and control high temperature manufacturing processes for semiconductors, composites, and materials formed by rapid solidification processes.

DESCRIPTION: High temperature material synthesis requires the accurate measurement and control of the temperature of the material, including the temperature uniformity material. For real time process control, temperature measurements must be performed at temperatures as high as 1000 - 1500 degrees centigrade without disturbing or altering the material growth process. Accurate high temperature measurements under a diverse set of process conditions is essential to the improvement of material manufacturing processes for defense applications.

Phase I: Evaluate non-contact techniques to measure material at elevated process temperatures. Simulate process conditions for semiconductors, metals and composites to reproduce the manufacturing process. Correlate non-contact temperature measurements with a direct measure of material temperatures under the same processing conditions.

Phase II: Integrate the evaluation technique assessed in the first phase into a manufacturing process. Evaluate the influence of the process conditions on the accuracy of the temperature measurements. Document the material properties and cost reductions associated with the incorporation of the improved temperature measurement.

DARPA 91-031 TITLE: Software Development Tools for Computer Integrated Manufacturing Systems

CATEGORY: Advanced Development

OBJECTIVE: Develop software tools and methodologies which will aid in the specification, design and implementation of Computer Integrated Manufacturing (CIM) systems especially to support the manufacture of integrated circuits.

DESCRIPTION: With rapid growth in product complexities and intense international competition, manufacturers are increasingly turning to CIM systems to help boost manufacturing yield, product quality, and factory utilization. Unfortunately, these systems often fail to meet their objectives or turn out to be much more expensive than anticipated. While general purpose Computer Aided Software Engineering (CASE), modeling, and simulation tools have provided CIM system are developers some leverage, their utility is often limited by their generality. Tools specifically tailored for developing CIM systems are needed which take advantage of emerging standards in various manufacturing segments. Tools which provide the capability for representing manufacturing requirements, provide for modeling equipment behavior and real time constraints, and assist in implementing reliable and distributed systems are also needed.

Phase I: Survey current work on tools and methodologies for developing and fielding CIM systems. Develop detailed requirements to support the development of CIM systems for semiconductor manufacturing. Specify a methodology for CIM system development and propose one or more software tools which implement all or part of that methodology.

Phase II: Prototype one or more of the proposed software tools. Demonstrate its utility by developing one or more subsystems of a semiconductor manufacturing CIM system. Refine the development methodology.

DARPA 91-032 TITLE: Designs and Concepts for High Performance Uncooled Infrared Imaging Sensors

CATEGORY: Advanced Development

OBJECTIVE: Develop the technology for an infrared imaging sensor that operates at or near room temperature with the performance required for target acquisition, surveillance and man-portable imaging system requirements, and has the potential for application as a thermal imaging inspection system for manufacturing.

DESCRIPTION: Infrared imaging sensors operating at cryogenic temperatures with sensitivity in the 3-20 micrometer spectral band have demonstrated the performance to meet imaging system requirements. The cooling required for these arrays often precludes their application in a manufacturing environment. Concepts for uncooled imaging sensors have been proposed and the feasibility of uncooled infrared sensors has been demonstrated for selected applications. However, the performance of the uncooled sensor must be improved before implementation in many applications, including inspection for defects in manufacturing. The sensitivity and resolution of the uncooled sensor must be increased to provide the performance necessary for both imaging and manufacturing inspection applications.

Phase I: Evaluate the performance of the uncooled imaging sensor for both imaging and manufacturing applications. Assess the thermal responsivity, noise and resolution assessed relative to proposed applications in both thermal imaging and manufacturing. Conduct a survey of the state of the art of uncooled sensors for manufacturing applications. Recommend improvements in sensor and signal processor performance, as necessary to meet manufacturing applications.

Phase II: Develop a prototype for both manufacturing and target acquisition applications based on the designs evaluated in the first phase. Document the performance of the uncooled array and thoroughly describe the cost benefits of thermal imaging inspection systems in manufacturing.

DARPA 91-033 TITLE: Novel Materials for X-Ray Lithography Masks

CATEGORY: Advanced Development

OBJECTIVE: To develop membrane/absorber lithography mask combinations compatible with high resolution definition and high structural stability.

DESCRIPTION: X-ray lithography will be used in the future to make semiconductor devices having features of 0.25 micrometers and below. The patterns are defined by proximity printing with x-rays of about one nanometer wavelength and x-ray lithography masks. Currently, the mask is made by patterning a thin film of high atomic number, such as gold, onto a thin membrane, such as silicon, and then bonding it to a quartz ring for handling purposes. Structural stability is required because of the extremely critical dimensions in advanced integrated circuits. Distortion, from stress and thermal effects, must be minimized. The materials should be compatible with the processing required to define the small features in the absorber layer. The thin membrane must support a pattern area of greater than 2 cm x 2 cm. Optical transparency of greater than 50% for the membrane is desired. Candidate membrane materials include silicon carbide and diamond; candidate absorber materials include tungsten and tantalum. The totality of mask fabrication will involve a sequence of discrete fabrication steps; any subset that fits reasonably well into an integrated plan will be considered.

Phase I: Select candidate materials and define processing steps. Develop a plan for how these may be integrated into a complete mask making process, evaluating effects between the various material properties and processing steps. Evaluate this plan against the many, varied requirements of masks in semiconductor manufacturing.

Phase II: Fabricate prototype samples and characterize. Deliver samples to third-parties for independent evaluation. Evaluate projected cost of appropriate subset in the mask fabrication sequence and under anticipated market conditions.

DARPA 91-034 TITLE: Development of a Substitute for Highly Toxic Arsine Gas for Use in Fabrication of Gallium Arsenide Material

CATEGORY: Advanced Development

OBJECTIVE: To develop alternatives to arsine which will be readily accepted by existing and future industries using metalorganic chemical vapor deposition (MOCVD) and gas-source molecular beam epitaxy (MBE) growth systems.

DESCRIPTION: MOCVD and MBE are accepted techniques for the growth of epitaxial layers. In particular, MOCVD of III-V semiconductor devices has been most successful and several production facilities are in operation. These include the production of

microwave and millimeter wave integrated circuits, laser diodes of compact disc players, photocathodes for night vision goggles, and gallium arsenide (GaAs) solar cells. The principal weakness of current MOCVD methods is reliance on arsine as Group V source. Arsine is highly toxic and requires the installation of major facilities with expensive monitoring and safety equipment. Even though the technology for handling arsine is well developed, accidental release of a large quantity of arsine remains possible. Such a catastrophic failure could trigger the temporary or permanent shut-down of all facilities using arsine and interrupt the supply of devices that are critical for defense needs.

Phase I: Determine optimum conditions and parameters for growth of GaAs MOCVD using alternate sources. Study the range of acceptable VIII ratios and compare with those presently used for MOCVD material growth. Develop simple test device structure(s) and compare results achieved using alternate sources with those obtained using standard MOCVD sources.

Phase II: Continue device development effort with a concentration on more complex device structures. Demonstrate device capabilities achieved using arsine replacement sources. Develop prototype growth system utilizing alternative environmentally safe sources as a replacement for arsine gas. Demonstrate prototype alternative source growth system capabilities including the potential for scale-up to large diameter (4 inch) substrates.

DARPA 91-035 TITLE: Code Development Tools and/or Assistants for Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for software development tools and/or assistants to support development of software for scalable parallel computers that can be developed into functioning code for highly parallel multicomputers and multiprocessors.

DESCRIPTION: Innovative concepts are sought for developing software development tools and/or assistants of beta release quality for highly parallel multicomputers and/or multiprocessors. The software should be fully compatible with the workstation server model. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed software--principles of operation, interfaces, display features, etc. Describe new or novel ideas or concepts. Describe use of proposed software; focus on its use in current or developing parallel computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (coded for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-036 TITLE: Compiler Technology for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for advancing compiling technology for scalable parallel Computers.

DESCRIPTION: Innovative concepts are sought for advancing compiling technology, particularly parallelization and optimization, for scalable parallel computers. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe parallel language features. Demonstrate how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on scalable parallel systems.

Phase II: Develop the software module (coded for scalable parallel computer) which implements the new compiler technology. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-037 TITLE: Graphically Based Debugging Technology for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for advancing, graphically based debugging technology for scalable parallel computers.

DESCRIPTION: Innovative concepts are sought for advancing graphically based debugging technology, particularly non-intrusive concepts, for scalable parallel computers. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed concept, principle, or algorithm. Describe new or novel ideas or concepts. Describe how the new technology would work in the workstation server model. Demonstrate how the new concept, principle, or algorithm would be used. Finally, describe the path or process for implementation on scalable parallel systems.

Phase II: Develop the software module (coded for scalable parallel computer) which implements the new debugging technology. Demonstrate the effectiveness of the new technology. Provide documentation that clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA91-038 TITLE: Scalable Algorithms and Software Library Modules for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for scalable algorithms and software library modules that can be developed into functioning code for highly parallel multicomputers and multiprocessors.

DESCRIPTION: Innovative concepts are sought for developing scalable algorithms and software libraries of beta release quality for highly parallel multicomputers and/or multiprocessors. The software should be fully compatible with the workstation server model. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed software--collection of algorithms, library, or tool. Describe new or novel ideas or concepts. Describe use of proposed software; focus on its use in current or developing parallel computer environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (coded for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system interface. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-039 TITLE: Performance Analysis and Performance Tuning Tools for Scalable Parallel Computers

CATEGORY: Exploratory Development

OBJECTIVE: Explore novel ideas for performance analysis and code tuning, particularly graphically based techniques, that can be developed into functioning code for highly parallel microcomputers and multiprocessors.

DESCRIPTION: Concepts are sought for innovative and novel ideas for developing, performance analysis and code tuning tools of beta release quality for highly parallel multicomputers and/or multiprocessors. The software needs to be fully compatible with the workstation server model. Concepts must be described at a high enough level to be system independent and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed software--principles of operation, interfaces, display, features, etc. Describe new or novel ideas or concepts. Describe its use; focus on its use in current or developing parallel computing environments. Finally, describe the path or process for obtaining beta release quality.

Phase II: Develop the software module (code for scalable parallel computer) collection of algorithms, library routine, or tool. Develop a users manual which clearly describes any external interfaces or requirements, how to use the software module, and the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-040 TITLE: Design and Construction of Image Content-Addressable Databases

CATEGORY: Exploratory Development

OBJECTIVE: Development of techniques for constructing databases of images that can be retrieved based on the contents of the images.

DESCRIPTION: In many applications, users have large databases of images that they would like to be able to access based on the contents of the images. There are, however, many questions that must be answered before this could be done. For example, what information besides an image itself must be stored along with it? Where is this information to come from? Is it to be automatically or manually extracted from the image or is it to come from some other source? How is the user to specify the "contents" of images of interest?

Phase I: Theoretically analyze and answer the above and other relevant questions and develop technique for accessing images based on that analysis.

Phase II: Explore and prototype implementation of the technique developed in Phase I.

DARPA 91-041 TITLE: Large Knowledge-Based System Benchmarks

CATEGORY: Advanced Development

OBJECTIVE: To establish community wide benchmark tasks and quantitative measures of evaluation to facilitate the evaluation of knowledge representation languages, artificial intelligence based reasoning methods, and knowledge-based tools.

DESCRIPTION: Novel ideas and approaches are sought that will lead to community wide acceptance of benchmark tasks and quantitative measures of evaluation to facilitate the evaluation of knowledge representation languages, artificial intelligence based reasoning methods, and knowledge-based tools. It is anticipated that the project will encompass the specification of benchmark tasks and quantitative measures of evaluation as well as a design specification of an instrumented test suite of tools. It is also anticipated that a prototype of the instrumented test suite will be developed and demonstrated on a representative large knowledge base.

Phase I: Develop specifications for benchmark tasks, quantitative measures of evaluation, and instrumented test suite.

Phase II: Develop prototype instrumented test suite of tools and demonstrate the benchmark tasks and quantitative measures of evaluation on a candidate large knowledge base.

DARPA 91-042 TITLE: Standards for Interoperable Knowledge-Based Systems

CATEGORY: Advanced Development

OBJECTIVE: To develop a candidate functional specification for an interoperability standard of a knowledge reasoning system integrated into a conventional system software environment.

DESCRIPTION: Scalability and seamless integration of existing knowledge-based system approaches into conventional system software environments is a critical concern. The anticipated work will focus on the development of an interoperability standard. It is anticipated that a prototype system will be implemented to demonstrate the strengths and weaknesses of the proposed standard.

Phase I: Develop a functional specification for an interoperability standard integrated into a conventional environment including, at a minimum, a state of the art, knowledge-based system and two or more relational databases. Describe an experiment to be performed in Phase II that includes quantitative measures of evaluation.

Phase II: Implement a prototype system based on the functional specification and evaluate the proposed standard based on quantitative criteria developed in Phase I.

DARPA 91-043 TITLE: Tools to Support Building and Maintaining Shared Ontologies

CATEGORY: Advanced Development

OBJECTIVE: To develop specifications and proof of concept prototypes of a new set of knowledge-based management tools to support sharing and reuse of knowledge bases.

DESCRIPTION: Novel approaches are sought that will enable a group of domain practitioners to share, reuse, and maintain a knowledge base. The anticipated research will focus on a specific engineering consideration of temporal and spatial information where inherent domain constraints make the candidate domain challenging but tractable. Capturing design intent and rationale are important, since design knowledge may be used for other purposes (for example, to generate diagnostics, to forecast life cycle costs). The research should develop an ontological description of the domain-independent and dependent features which can be understood and used by practitioners in the domain. The research should develop the specifications for intelligent tools that will assist in the creation and maintenance of these ontologies. A prototype set of tools should be developed and evaluated against a defined set of quantitative measures of evaluation.

Phase I: Describe the candidate domain, ontology, ontology creation and maintenance tools, and evaluation metrics.

Phase II: Develop the prototype ontology creation and maintenance tools and evaluate the prototype tools in the candidate domain.

DARPA 91-044 TITLE: Evaluation Methods and Metrics for Image Processing and Understanding Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: Development of methods for the evaluation of a wide variety of low, medium, and high level image processing and image understanding algorithms and techniques.

DESCRIPTION: Although there is general agreement that research in image processing and understanding has made great progress over the last fifteen years, there has been little progress in the development of methods for precisely characterizing and measuring this progress. In order to put the field on firm scientific footing and insure further significant progress, such methods are now needed.

Phase I: Summarize evaluation methods developed to date with detailed analyses of their shortcomings as well as a proposed set of new and improved methods.

Phase II: Explore and prototype implementation and demonstration of the new methods developed in Phase I.

DARPA 91-045 TITLE: Software Reverse Engineering Tools for Inclusion in Open Architecture Environments

CATEGORY: Advanced Development

OBJECTIVE: To develop advanced reverse engineering tool technology for software systems that can be experimentally integrated into emerging open-architecture software engineering environments. Specifically excluded are tools that implement a simple change of syntax from one language to another.

DESCRIPTION: High capability reverse engineering tools are sought that can support analysis of large scale existing systems, including detection of natural systems, component boundaries, establishing of abstract data types and invariants, and abstract characterization of function and performance. Acceptable proposals must produce demonstration tool capabilities that could be integrated effectively into a variety of open architecture environment approaches such as software technology for adaptable reliable systems (STARS) and Arcadia. Acceptable proposals must also include descriptions of the extent of program analysis performed in order to extract information from existing codes.

Phase I: Provide a detailed description of tool capability, associated technical documentation, an engineering design, an analysis of related research, and an indication of external interface requirements. The design should include requirements for underlying environment substrates.

Phase II: Develop a prototype capability suitable for experimental integration into one or more of the software engineering environments currently being developed in association with DoD.

DARPA 91-046 TITLE: Application of Image Understanding Techniques to Underwater Acoustic Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Application of Image Understanding (IU) techniques to the analysis of sonograms resulting from underwater acoustic signals.

DESCRIPTION: Interesting phenomena are frequently extracted by human visual examination of sonograms resulting from underwater acoustic signals. The purpose of this project is to find ways to help automate this process by applying established IU techniques to the interpretation of these sonograms.

Phase I: Define the sonogram understanding problem in IU terms and identify potential IU techniques that would be useful in solving this problem.

Phase II: Explore and prototype implementation and demonstration of the techniques developed in Phase I.

DARPA 91-047 TITLE: Open Architecture Hypertext and Group Coordination Support for Advanced Software Design Environments

CATEGORY: Advanced Development

OBJECTIVE: To design a generic hypertext capability that can be Included in software engineering environments for use in managing software configurations, software design information, and other large scale complex structured objects.

DESCRIPTION: As part of an advanced software engineering environment design effort, generic interfaces for advanced hypertext user-interaction capabilities are sought. Successful interface design will enable multiple competing hypertext components to be developed that support the high capabilities required in a software design environment. Specifically sought is the development of a set of natural internal systems interfaces for hypertext front-ends, along with a validation experiment to demonstrate feasibility of the interface design. Acceptable proposals must (1) indicate how the proposed technology will integrate into emerging open environment architecture conventions including those under development at DARPA, (2) include an analysis of related work, and (3) assess means to gain industry acceptance.

Phase I: Provide a detailed description of hypertext tool capability, associated interface design requirements, an analysis of related work in hypertext and associated interfaces, and an indication of external interface requirements. The design must include requirements for underlying environment substrates.

Phase II: Develop a prototype hypertext capability to enable validation of the interface designs. This capability must be suitable for eventual experimental inclusion in one of the software engineering environments currently being developed in association with DoD.

DARPA 91-048 TITLE: Software Design Documentation Record Structural Design

CATEGORY: Advanced Development

OBJECTIVE: Preliminary designs for a common data structure to represent software design documentation and library data.

DESCRIPTION: Data elements in a software design record can include, for example, code fragments, test cases, requirements specification fragments, interface and architecture specifications, informal and formal design rationale, catalog and search points, metric data, hypertext paths, configuration and version data, access rights, and linkage into repositories. DoD software systems often persist beyond tool life, which implies that design data must be tool-independent. The data structure must support trackable consistency, integrated version and configuration management, and appropriate visualization and hypertext support. Design generic interfaces for advanced software design documentation records. Provide for representation of software information well beyond that represented through existing mechanisms such as through the DoD CALS standard and DoD-STD-2167A. Develop a set of natural internal systems interfaces for software documentation information. Acceptable proposals must (1) indicate how the proposed technology will integrate into emerging open environment architecture conventions including those under development at DARPA, (2) include an analysis of related work, and (3) assess means to gain industry acceptance.

Phase I: Develop a detailed description of requirements for the design record data structure, a feasibility study for implementation, associated software environment architectural requirements, and an analysis of related work in software documentation management.

Phase II: Develop a prototype representation for software design records to enable validation of the interface designs. This capability must be suitable for eventual experimental inclusion in one of the software engineering environments currently being developed in association with DoD.

DARPA 91-049 TITLE: **Robust Fusion of Multi-Spectral and Multi-Temporal Images**

CATEGORY: Exploratory Development

OBJECTIVE: Development of techniques for fusing together information gathered from temporal sequences of images and/or images taken using different parts of the frequency spectrum.

DESCRIPTION: Images formed from sensors working at different parts of the spectrum provide different types of information about a scene. Major improvements in the quality and variety of such sensors provide an opportunity to build image understanding systems that take advantage of the availability of these new sensors and the additional information that they provide. Temporal sequences of images can provide additional information about changes taking place in a scene.

Phase I: Develop basic techniques for doing the type of image fusion described above.

Phase II: Explore and prototype implementation and demonstration of the techniques developed in Phase I.

DARPA 91-050 TITLE: Modular Open Architecture Intelligent Controllers for General Purpose **Machine Tools**

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel concepts for open architecture machine tool controllers, using, emerging RISC or parallel processors, with emerging NGC compatible software architectures.

DESCRIPTION: Innovative concepts are sought for developing modular, open architecture intelligent controllers utilizing advanced RISC or parallel processors to implement extremely low periodicity for machine tools.

Phase I: Provide a detailed specification of the proposed software -- principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale machine tool environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed machine tools in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, how to link additional machine tools to the system. A hardcopy and a

magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-051 TITLE: Improvements to Peripheral Security of Timeshare Systems

CATEGORY: Exploratory Development

OBJECTIVE: Improvements to peripheral security of timeshare system.

DESCRIPTION: Authentication of users of timeshare systems is key to the prevention of intrusion. Improved algorithms and authentication technology are sought for user authentication as well as system authentication for network services such as: login, rlogin, rep, ftp, rsh, nfs.

Phase I: Provide detailed specification of the intended use and structure of the proposed security measure with complete interface definition.

Phase II: Develop the prototype of the security measure defined in Phase I including users manual. Deliver source and object in UNIX Tar format.

DARPA 91-052 TITLE: Computer Supported Cooperative Work Software Architecture Design for Mechanical Design and Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel scalable software architectures for computer supported cooperative design of mechanical parts and assemblies.

DESCRIPTION: Innovative concepts are sought for developing and analyzing software architectures for scalable, distributed computer supported cooperative design of mechanical parts and assemblies. Concepts must include initial concept design, geometric design, parametric design, mechanical analysis, manufacturing analysis, and assembility analysis. Concepts must be described at a high enough level to be system independent, and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed software -- principles of operation, interfaces, display features, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale design environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed design tools in a seamless, scalable fashion. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, and how to use the architecture to link additional design tools to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-053 TITLE: Design Documentation Record Architecture in Mechanical Computer Aided Design Environment

CATEGORY: Exploratory Development

OBJECTIVE: To develop novel design record specifications and descriptions supporting design history, design issues, and life-cycle design decisions for Mechanical Computer Aided Design (MCAD) Environments.

DESCRIPTION: Innovative concepts are sought for developing design documentation record software architectures for scalable, distributed computer supported cooperative design of mechanical parts and assemblies. Concepts should include initial concept design, trade analyses, geometric design, parametric design, mechanical analysis, manufacturing analysis, process planning, and assembility analysis. These Concepts must be described at a high enough level to be system independent, and have clearly defined and open interfaces.

Phase I: Provide a detailed specification of the proposed design documentation record structure -- principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed design record; focusing on its use in large scale design environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed design tools in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, and how to use the design record to link additional design tools to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-054 TITLE: Integration of Multi-Spectral Sensors in Modular, Open Architecture Controllers for Precision Control of Metal Cutting Machinery

CATEGORY: Advanced Development

OBJECTIVE: To develop novel concepts for integrated, multi-spectral sensor packages specifically targeting increased dimensional accuracy and surface quality of machining processes using existing machine tools.

DESCRIPTION: Innovative concepts are sought for developing integrated multi-spectral sensor packages, including acoustic, thermal, piezeo-electric vibration, velocity and torque sensors for active real-time tool wear monitoring and control in conjunction with Modular, Open Architecture Intelligent Controllers for machine tools.

Phase I: Provide a detailed specification of the proposed software--principles of operation, interfaces, information model, communication features, etc. Describe new or novel ideas or concepts. Describe the use of the proposed system, focusing on its use in large scale metal cutting environments. Articulate a plan or process for obtaining beta release quality.

Phase II: Develop a software architecture and module, capable of interfacing with a minimum of three existing or proposed cutting machines in a seamless, scalable fashion utilizing the specification developed in Phase I. Demonstrate scalability of approach over several interfaces, one of which must be long distance networked communications. Develop a user manual which clearly describes any external interfaces or requirements, how to link additional cutting machines to the system. A hardcopy and a magnetic media copy of the code are required. The magnetic media is to be delivered in ASCII form and must be in Unix Tar format.

DARPA 91-55 TITLE: Novel Applications of Superconductor Technologies to Satellites

CATEGORY: Exploratory Development

OBJECTIVE: Apply superconductor technologies to reduce the size, weight, power consumption, and/or cost of satellite subsystems and components; improve the performance of current state-of the-art systems; and facilitate new capabilities not previously possible other technologies.

DESCRIPTION: Superconducting materials possess unique physical properties (perfect diamagnetism, high current density and magnetic field capabilities, dissipationless conduction, etc.) which are not available in other materials. Advances over the past five years have reduced high temperature superconductors (Tc > 77°K) and the promise of room temperature materials. The potential exists for noncryogenically cooled devices to operate in the superconducting state under ambient conditions in space (either present materials or higher Tc materials). Potential application areas of interest for space systems include RF devices, sensors, hybrid microelectronics (super/semiconductor integrated circuits), superconductor device based microelectronics, and others. Examples of potential advantages derivable from these emerging technologies include faster microelectronic device switching times with reduced thermal dissipation leading to greater packaging densities; smaller, lighter electronic components that dissipate less energy as waste heat; and sensors with improved sensitivities vis-a-vis other technologies. Additionally, novel applications in areas such as propulsion, spacecraft stabilization and attitude control, high density energy storage devices may facilitate new or improved capabilities for spacecraft. For example, spacecraft might be magnetically stabilized in attitude and/or spin rate by superconducting magnetorquers, and in principle sufficiently strong magnetic gradient forces may be developed in the earth's field to propel a spacecraft (with low thrust but very large specific impulse).

Phase I: Develop a superconductor application concept to meet one or more of the research objectives. Investigate key scientific and systems engineering considerations to provide: (1) theoretical justification of the proposed concept; (2) notional space system implementation concept, with emphasis on the effects of the space environment (radiation, thermal control outgassing, etc.); (3) advantages of the proposed concept over alternative technologies; and (4) discussion of utility and significance for national defense space systems.

Phase II: Estimate the cost to perform a laboratory proof-of-principle demonstration of the proposed concept and a rough order of magnitude cost to perform a space-based demonstration.

DARPA 91-056 TITLE: Shape Memory Alloy Material Development for Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Develop shape memory alloys with properties and stock sizes and configurations which are not currently available. The ultimate goal of this effort will be to develop actuators for use in one or more naval applications.

DESCRIPTION: DARPA is interested in the development of quiet, self-contained actuator technology which utilizes shape memory alloy (SMA) materials for naval applications. The material used at present is a nitinol (Ni-Ti) alloy which is available as wire with diameters of 0.003 - 0.010 inch (0.08 - 0.25 mm). Future applications of this technology are limited by the load capacity,

the life cycle duration. and the cycle frequency of these wires. The cycle frequency is primarily limited by cooling rate. To mitigate these limitations DARPA is interested in the development of shape memory alloy materials with any or all of the following properties.

(1) Alloys which transition from austinite to martensite and back to austinite over a narrow temperature range (as low as 1°C).
(2) Alloys which transition at high temperatures (up 150°C).
(3) Alloys with life cycles of 10 - 100 million cycles without degradation of performance and strength.
(4) Alloys with working strengths up to or exceeding 100,000 psi.
(5) Stock with cross sectional areas up to 0.1 sq. in. (65 sq. mm).
(6) Stock in other configurations with large surface to volume ratios such as foil, flat stock, tubing, or wire rope.

Phase I: The results of the Phase I effort should include delivery of one or more samples of SMA material.

Phase II: The Phase II effort would include delivery of a sufficient quantity of material to develop prototype actuators and could include the design and construction of prototype actuators.

DARPA 91-057 TITLE: In-Situ Direct Vorticity Measurement System

CATEGORY: Advanced Development

OBJECTIVE: Develop a non-intrusive system for directly measuring the vorticity vector field around submerged vessels.

DESCRIPTION: DARPA is interested in locating sources of vorticity and the evolution of vorticity shed from surfaces or large-scale underwater vehicles. Emerging laboratory-scale optical techniques for direct, non-invasive measurement of vorticity vectors can potentially be further developed to satisfy this need. An instrument that can be mounted either within a test vehicle or outside of the test facility and probe the vorticity field around the vehicle is desired. The instrument should ultimately be capable of rapidly measuring all three components of the vorticity vector at specified points in the flowfield and of providing second-order moments of vorticity fluctuations. Spatial resolution as small as the Kolmorgorov microscale is desirable.

Phase I: Demonstrate the feasibility of scaling up an existing laboratory vorticity measurement system to meet DARPA requirements.

Phase II: Develop, deliver, and demonstrate system at a selected test site.

DARPA 91-058 TITLE: Innovative Underwater Launch Concept for an Endurance Unmanned Aerial Vehicle

CATEGORY: Advanced Development

OBJECTIVE: A proof-of-concept demonstration of the underwater launch of an endurance unmanned aerial vehicle (UAV).

DESCRIPTION: Technologies are rapidly maturing for UAV platforms and their sensors. A practical implementation of a UAV underwater launch concept would extend the operational capabilities of endurance UAVs.

Phase I: Illustrate a monitoral launch concept by developing a design which clearly articulates the concept's features.

Phase II: Prove the concept's viability by designing and developing a working model and demonstrating its practicality relative to an endurance UAV and its underwater host platform.

DARPA 91-059 TITLE: Multi-Sensor Management Techniques for a High Altitude Long Endurance Unmanned Aerial Vehicle

CATEGORY: Advanced Development

OBJECTIVE: A generic multi-sensor management technique optimizing the capabilities of high altitude long endurance (HALE) unmanned aerial vehicle (UAV) systems over a broad range of mission application and operating environments.

DESCRIPTION: Miniaturization of surveillance sensors coupled with other HALE UAV avionics advancements are expanding automated mission capabilities. Multi-spectral payload onboard management techniques are needed to complement these developments.

Phase I: Illustrate multi-sensor management by designing an onboard management technique which is applicable to a variety of sensors and compatible with a HALE UAV.

Phase II: Demonstrate the management process using existing/simulated platform and sensor characteristics to illustrate effective sensor crosscueing and overall optimal sensor coverage.

DARPA 91-060 TITLE: New Approaches to Long Wavelength Infrared Imaging Devices

CATEGORY: Basic Research

OBJECTIVE: To explore new materials and device structures to provide an alternative to mercury-cadmium-telluride (MCT) for fabricating staring infrared imagers capable of operating in the 8 to 12 micrometer atmospheric window.

DESCRIPTION: There is a need to identify and demonstrate the feasibility of new materials, systems or device structures that respond to long wavelength infrared radiation. The materials or devices of interest must have a potential advantage over MCT based detection systems. The advantage could be derived from projected lower cost, simpler fabrication technology, better uniformity or any other significant characteristic that is significant to infrared imaging arrays. Preferably, the new system should have an advantage in more than one of the before mentioned factors.

Phase I: Identify and fabricate a structure that allows basic physical measurements, from which array performance can be predicted.

Phase II: Design and fabricate an infrared imaging array, with at least 64 by 64 pixels. Characterize the array performance over the 8 to 12 micrometer band.

DARPA 91-061 TITLE: Diode Pumped Upconversion Lasers in the Blue-Green Wavelength Region

CATEGORY: Basic Research

OBJECTIVE: To develop diode pumped solid state lasers in the blue-green wavelength region, based on upconversion of energy stored in long-lived, rare earth ion states.

DESCRIPTION: Upconversion lasers are a new class of lasers to obtain visible wavelengths without the need for external nonlinear processes for wavelength conversion from the output of Nd:YAG lasers. Wavelengths ranging from the violet to deep red can be obtained from energy stored in long-lived states of rare earth ions through the upconversion process. Most require one or two pump photons in the red or near infrared region. The pump photons can be obtained from laser diode arrays tailored in output wavelength to the specific crystal. This program seeks to demonstrate the possibility of new upconversion lasers involving rare earth ions other than those demonstrated to date. Specific wavelength outputs to be demonstrated are in the blue-green region of the visible spectrum.

Phase I: Identify and demonstrate upconversion lasers in the blue-green wavelength region in rare earth doped laser crystals other than those demonstrated to date.

Phase II: Demonstrate energy scale up and determine the diode pumping requirements of the upconversion lasers demonstrated in Phase I.

DARPA 91-062 TITLE: Organic Nonlinear Materials for Wavelength Conversion

CATEGORY: Basic Research

OBJECTIVE: To develop new nonlinear organic materials for efficient wavelength conversion.

DESCRIPTION: Organic materials have high nonlinear coefficients and higher damage thresholds compared to inorganic compounds. This program is to examine new classes of organic compounds, other than those reported to date. The goals of this program are: 1) synthesis and characterization of relevant crystalline and nonlinear optical properties; 2) development of growth techniques; and 3) demonstration of efficient wavelength conversion and characterization of damage thresholds.

Phase I: Identify and characterize new nonlinear organic materials other than those reported to date.

Phase II: Develop growth techniques, demonstrate efficient wavelength conversion and characterize damage thresholds.

DARPA 91-063 TITLE: Multi-Frequency Laser Materials

CATEGORY: Basic Research

OBJECTIVE: To develop laser materials with multi-wavelength output.

DESCRIPTION: Self frequency doubling of fundamental wavelengths in Nd:YAB type crystals has been reported. This program seeks to develop laser materials, with multi-frequency outputs other than those already reported, either continuous wave or Q-switched. Such laser crystals, can be diode laser pumped or with inexpensive sources with output tailored to match the broad absorption lines of the laser materials. Such pump sources must be compact, efficient and comparable to laser diodes.

Phase I: Identify and characterize multi-frequency output laser materials.

Phase II: Further develop laser materials identified and characterized in Phase I. The efforts will address stable laser operation and crystal growth techniques.

DARPA 91-064 TITLE: Using Diode Lasers for Compact Eye-Safe Laser Radar

CATEGORY: Exploratory Development

DESCRIPTION: This program seeks to develop compact, low cost eye-safe laser radar using 1.54 micrometer laser diodes. The laser radar system will have numerous applications that require eye-safe operation. This program will address the conceptual design, component development issues, and breadboard integration and field demonstration of the concept.

Phase I: Develop conceptual designs and systems analysis of eye-safe laser radar using 1.54 micrometer laser diodes.

Phase II: Based on the results of Phase I study, develop bread board laser radar system and demonstrate in the field.

DARPA 90-065 TITLE: Detection and Analysis of Random-Pulse Ultra-wide Band Signals

CATEGORY: Exploratory Development

OBJECTIVE: The development of an ultra-fast signal processor that can analyze random impulse signals.

DESCRIPTION: Repetitive impulse signals can be detected quite accurately if they are properly stored and integrated. On the other hand the detection and the analysis of random impulse signals are not so straightforward. Conventional electronics can detect and analyze single electromagnetic signals with bandwidths up to several GHz. Above that, even propagation through transmission lines or connectors can degrade the signal to be analyzed. Ultra fast techniques (e.g. electro-optical) that do not require integration are necessary.

Phase I: Develop the methodology of the detection scheme.

Phase II: Demonstrate detection techniques and features with a proof-of-principle experiment.

DARPA 91-066 TITLE: Low Temperature Diamond Film Deposition for Thermal Management

CATEGORY: Advanced Development

OBJECTIVE: To develop low-temperature Chemical Vapor Deposition (CVD) processes for high thermal conductivity diamond films.

DESCRIPTION: The development and application of high speed electronic devices is often limited by self-generated thermal loads. As the speed of these devices increases, heat dissipation and thermal management become increasingly important and frequently restrict system design. Diamond films deposited directly on microelectronic devices are projected to be very effective in spreading and dissipating the generated heat to the surrounding package. However, current CVD diamond processes operate at fairly high substrate temperatures (ie. approximately equal to 800°C) to achieve high purity and thermal conductivity. Therefore, low temperature deposition processes that would be compatible with silicon and gallium-arsenide devices, are of considerable interest.

Phase I: Develop and demonstrate low-temperature diamond deposition process and confirm by Raman spectroscopy and X-ray/electron diffraction analysis.

Phase II: Scale-up process, measure diamond thermal conductivity, and diamond coat silicon and gallium-arsenide integrated circuit devices.

DARPA 91-067 TITLE: Advanced On-Line Sensor for Materials Manufacturing, Process Control, and Quality Assurance

CATEGORY: Exploratory Development

OBJECTIVE: To develop and apply innovative process and product quality in-situ sensors, for monitoring and controlling key process parameters during chemical vapor deposition (CVD) of diamond.

DESCRIPTION: Close tolerance manufacturing control and on-line quality assurance require in-situ sensors to measure and control key process parameters and/or the state of the material in production. The chemical vapor deposition of diamond is a process with significant potential application to DoD systems, however, at present this empirical process often produces anomalous results and undesirable film characteristics. It is anticipated that on-line sensing of key process parameters or product qualities such as gas compositions and concentrations, or diamond film orientation and crystallite size will enable closed-loop feedback control of the process and insure product quality. Innovative sensing concepts with potential for application in a manufacturing

environment are of particular interest.

Phase I: Demonstrate one or more in-situ sensing approaches for CVD diamond processing.

Phase II: Develop sensor(s) and apply in CVD diamond processing system and correlate sensor data with diamond film qualities.

DARPA 91-068 TITLE: **Applications of Data Fusion to Signal Processing**

CATEGORY: Exploratory Development

OBJECTIVE: To distinguish objects of interest in signal processing environments through application of data fusion principles.

DESCRIPTION: There are many signal processing environments where no single measure of the data can distinguish the objects of interest. However, by computing many different properties of the signal it may be possible to "fuse" the results to distinguish the objects of interest.

Phase I: Determine a signal processing problem of current interest to the DoD and the properties computations that could distinguish objects of interest. Indicate a fusion method for making the ultimate signal identification.

Phase II: Using off the shelf hardware, construct a prototype to demonstrate the results of Phase I.

DARPA 91-069 TITLE: Intelligent Control Related to Materials Manufacturing

CATEGORY: Exploratory Development

OBJECTIVE: To create a method of controlling a material manufacturing process, where the material(s) would find applicability in a DoD weapons system.

DESCRIPTION: Choose a materials manufacturing task and describe the nature of sensors and methods that can be used to effectively control the process.

Phase I: Determine a problem, the sensor locations and outputs, and provide a design for an intelligent controller.

Phase II: Produce a demonstration or numerical simulation to verify the design.

DARPA 91-070 TITLE: Novel Concepts for Processing Structural Ceramic Composites

CATEGORY: Exploratory Development

OBJECTIVE: To synthesize and process fiber-reinforced and whisker-reinforced ceramic matrix composites, with the goal of increasing room temperature and elevated temperature toughness and strength, to values substantially above those for monolithic ceramics.

DESCRIPTION: Ceramic composites are of interest to the DoD for a variety of applications: high temperature structural materials for aircraft and missiles, armor, gun barrel liners, and a variety of wear-resistant applications. Novel processing techniques to produce net shape low cost composites will be given high priority.

Phase I: Process ceramic composites to dense bodies, determine room temperature toughness and strength, and conduct microstructural characterization.

Phase II: Optimize mechanical properties (strength, toughness, creep resistance) at both room temperature and elevated temperature. Fabricate and evaluate demonstration components.

DARPA 91-071 TITLE: Processing of Molybdenum Disilicide ($MoSi_2$) Matrix Composites

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative, low-cost processing approaches to production of $MoSi_2$ composites and to develop high-temperature, material, property correlations to these processing approaches.

DESCRIPTION: Molybdenum Disilicide is known to have extraordinarily high temperature environmental resistance and reasonably low density; however, the lack of room temperature fracture toughness and poor high temperature creep resistance has severely limited its structural applications. However, this material is an excellent candidate for development as a matrix material in high-temperature structural composite systems. Innovative, low-cost processing concepts are desired for processing of $MoSi_2$ matrix composite systems for structural applications.

Phase I: Identify one or more composite systems and innovative low-cost processing approaches. Develop a plan for processing the material and perform an analytical evaluation of the properties of the composite system.

Phase II: Develop and demonstrate the composite processing system and measure product material properties.

DARPA 91-072 TITLE: Development of CO_2 Rejecting Electrolytes for Fuel Cells

CATEGORY: Exploratory Development

OBJECTIVE: To develop electrolytes that will effect the rejection of by-products of electrochemical oxidation occurring at the anode of hydrocarbon fuels and methanol. In particular, the electrolytes must be compatible with the anode catalyst and be highly efficient in the rejection of CO_2 and perform well in experimental fuel cell stacks.

DESCRIPTION: The direct oxidation of methanol and other hydrocarbon fuels will permit a fuel cell to be operated without a reformer, which in turn will provide a higher system power density at lower temperatures (about 100°C). A key problem with available electrolytes is their failure to efficiently reject the products of oxidation and especially CO_2.

Phase I: Develop candidate electrolytes that show promise for efficient rejection of electrochemical oxidation products.

Phase II: Incorporate the candidate electrolytes developed under Phase I in direct oxidation at the anode fuel cell stacks, including methanol, and demonstrate their efficiency and performance.

DARPA 91-073 TITLE: Super Acid, Solid Electrolyte Catalysts for Fuel Cells with Direct Oxidation of Hydrocarbon Fuels

CATEGORY: Exploratory Development

OBJECTIVE: To develop super acid, solid electrolyte catalysts for fuel cells that will affect the direct oxidation of methanol and hydrocarbons at the anode with high efficiency. Candidate catalysts will be tested in near-ambient temperature experimental fuel cell stacks and their performance and efficiency will be evaluated.

DESCRIPTION: The direct oxidation at the anode of methanol and hydrocarbon fuels may be affected by the use of super acids in a solid electrolyte environment. This would result in the development of fuel cells with high power density which operate at near-ambient temperatures.

Phase I: Develop candidate superacids and compatible electrolytes.

Phase II: Incorporate the candidates from the Phase I program into an experimental fuel cell stack and demonstrate their performance and efficiency.

DARPA 91-074 TITLE: Fuel Cell Catalysts for Direct Oxidation of Methanol

CATEGORY: Exploratory Development

OBJECTIVE: To develop catalysts that will efficiently effect the oxidation of methanol at the anode of near ambient temperature fuel cells. Candidate catalysts will be tested in an experimental fuel cell stack and their performance and efficiency will be evaluated.

DESCRIPTION: The direct oxidation of methanol allows a fuel cell to be operated without a reformer leading to more rapid start-up times and higher system power density. At the present time the main drawback in methanol electrocatalysis is the formation of strongly adsorbed intermediates that block or inhibit the reaction. New supported catalysts are sought which will significantly improve current density and enhance long-term operation without unduly increasing system cost. Approaches that integrate a fundamental understanding of the catalysis and surface chemistry with novel electrode structure design, fabrication and evaluation will receive serious consideration.

Phase I: Develop candidate catalysts that show promise for incorporation into methanol fuel cells.

Phase II: Build and test a prototype fuel cell that incorporates the catalysts developed under the Phase I program.

DARPA 91-075 TITLE: Assessment of Materials, Structures, and Component Development Using Advanced Combat Models

CATEGORY: Advanced Development

OBJECTIVE: To provide a method for measuring cost effectiveness of the insertion of advanced materials and structures into modern weapons systems.

DESCRIPTION: In the development of components and subsystems for weapon performance enhancement, modeling of

battlefield results has never been carried out to develop a true cost benefit analysis. This can best be accomplished with advanced decision methodology specifically designed for incorporating results from computer modeling of force-on-force wargaming. This would effectively capture and treat combat simulation results in the form of probabilistic and well-defined variables, thereby making the tool available to development scientists.

Phase I: For an appropriate component set determine how performance information will be selected, how it will be inserted into a battlefield model, and how cost-benefits will be analyzed. Select an appropriate decision methodology and conduct an analysis to demonstrate the suitability of the method to handle wargaming results. Evaluate a hypothetical weapon system enhancement with actual model runs, obtaining a cost-benefit analysis.

Phase II: Perform extensive battlefield modeling of an approved selection of components, resulting from advanced materials and structures development. Conduct a sensitivity analysis based on possible ranges of materials properties in the components, to allow judgements to be made on the criticality of materials development. Provide an assessment of the utility of the developed decision method for guiding materials and structures research and development. Document the methodology for efficient technology transfer to agency users.

DARPA 91-076 TITLE: Application of High Temperature Superconductors to Electronic Circuitry

CATEGORY: Advanced Development

OBJECTIVE: To determine how high temperature (nominally 80K) superconducting materials can be introduced into electronic circuitry to enhance overall properties of signal dispersion, frequency response, packing density, reduced crosstalk and reduced power dissipation.

DESCRIPTION: The recent discovery of high temperature ceramic oxide superconductors has important implications in advancing the capabilities of electronic components and circuitry. The phasing of this insertion into electronics probably will begin with the replacement of normal metal interconnects with superconducting leads and transmission lines.

Phase I: Select an appropriate electronics package and determine how a computer-aided-design code can be modified to accommodate superconducting leads and transmission lines. Determine how the code must be adjusted to optimize the layout geometry according to the special properties and processing requirements of superconducting materials. Prioritize the types of superconducting insertions and evaluate their cost-benefit within the upgraded electronics package.

Phase II: Carry out the modifications of a CAD code to insert superconducting leads and transmission lines, from Phase I. Compare the predicted performance of the electronic circuitry to that of the standard electronics package. Translate the code into design instructions for the layout of the superconducting circuitry. Contract the deposition and configuration of the superconducting circuitry and evaluate its performance relative to the standard circuit.

DARPA 91-077 TITLE: Thin Film, High Dielectric Constant, Micron Sized Capacitor Materials

CATEGORY: Exploratory Development

OBJECTIVE: To explore high dielectric materials for use in thin film capacitors for semiconductor electronics, and to develop deposition techniques that yield high quality capacitors using these materials.

DESCRIPTION: Thin film capacitors in DRAMs and other electronics take up significant area. In order to reduce the area consumed by these devices, the capacitors are grown in trenches. DARPA is interested in exploring alternative materials with significantly higher dielectric constants that could be used to produce very small area capacitors without the necessity of growing them in trenches.

Phase I: Identify candidate high dielectric materials which are likely to be compatible with semiconductor electronics, both during processing and longterm use.

Phase II: Develop processing techniques, including deposition and patterning, to produce thin film, high dielectric capacitors using the materials identified in Phase I. Electrically characterize the resulting capacitors. Explore any significant obstacles to scaling-up the process to high density electronics.

DARPA 91-078 TITLE: Neural Net Applications Leading to Hardware Implementation

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop prototype neural net hardware systems for specific applications.

DESCRIPTION: DARPA is interested in receiving innovative proposals leading to the implementation of artificial neural network (ANN) methods using dedicated hardware. Each proposal should address a specific ANN application which: (1) is of clear importance to the Department of Defense, (2) has already been demonstrated using software simulations on general purpose computers, and (3) is expected to improve in performance and/or utility through implementation in dedicated ANN hardware.

Phase I: Verify the feasibility and anticipated advantages of implementing the chosen ANN application in dedicated hardware, and develop a detailed plan and design for doing so.

Phase II: Accomplish the hardware implementation, including all needed ANN training and testing, and evaluate and demonstrate the performance and utility of the resulting system in relation to a specific military application.

DARPA 91-079 TITLE: Device Phenomena Unique to Sub-Micrometer Devices

CATEGORY: Basic Research

OBJECTIVE: To identify and study novel phenomena unique to sub-micron electronic devices.

DESCRIPTION: As electronic device dimensions shrink, new phenomena appear. Some of these effects are classical (e.g. short channel effect) and some are quantum mechanical (e.g. resonant tunneling). Because DARPA continues to pursue programs to raise the density of electronics, DARPA is interested in exploring and understanding effects that can be used for making novel ultra-small devices or for producing more functionality per unit area of the chip even if the device size remains the same as present devices. Similarly, DARPA is interested in methods of circumventing deleterious effects in known devices as their dimensions are reduced.

Phase I: Identify phenomena that significantly influence existing electronic device performance as the device is reduced in dimensions or novel phenomena in sub-micron structures that could be used as the basis of new types of electronic devices.

Phase II: Explore these device phenomena theoretically and/or experimentally.

DARPA 91-080 TITLE: Integrated Spatial Light Modulators for Optical Processing with Incoherent Light

CATEGORY: Exploratory Development

OBJECTIVE: To develop a spatial light modulator that will respond to an incoherent light input and can be used in subsequent coherent optical processing.

DESCRIPTION: Materials that respond to incoherent light input with a refractive index change can convert 2D images into a coherent light representation.

Phase I: Prove that the candidate material will respond in the desired manner with sufficient sensitivity. Show compatibility to integration.

Phase II: Fabricate integrated spatial light modulator. Operate as optical processor.

DARPA 91-081 TITLE: Reproducible Growth Techniques for Ultra Thin Epitaxial Multilayers on III-V Substrates

CATEGORY: Advanced Development

OBJECTIVE: To perfect growth techniques for ultra thin (20-2500A) multilayers on III-V substrates at reasonable thruput. Custom designed wafers should be available upon the successful conclusion of this program at low cost and high reproducibility.

DESCRIPTION: The state of the devices in optoelectronics and electronics requires semiconductor materials engineered with thin layers and abrupt interfaces. At present, these materials are only available from individual researchers at very high cost and marginal reproducibility.

Phase I: Demonstrate proposed growth technique to clearly establish capability to grow sample material with thin film and abrupt interfaces.

Phase II: Demonstrate growth technique which produces high quality materials and can accommodate custom designs. Reasonable throughput should be achieved to enable low cost.

DARPA 91-082 TITLE: Chemical Biological Warfare Treaty Verification

CATEGORY: Exploratory Development

OBJECTIVE: To develop methodologies and technologies for enhanced US capability in Chemical Biological Warfare (CBW) monitoring and treaty verification.

DESCRIPTION: Improvements are needed in conventional and national capabilities for overt/covert monitoring of chemical and biological warfare (CBW) weapons production, munitions stockpiling and demilitarization. Also needed are an analysis of alternative manufacturing processes and their impact on the flow of raw materials and production by-products/waste products.

Use scenarios may range from (overt) routine and challenge on-site inspections to (covert) continuous monitoring of suspected production facilities. Efforts will focus on central research issues.

Phase I: Develop proposals which identify/describe hypothetical use scenarios (where appropriate) and describe novel methodological and/or technological insights.

Phase II: Provide initial proof-of-concept demonstration.

DARPA 91-083 TITLE: Advanced Military Medicine

CATEGORY: Basic Research

OBJECTIVE: Development of generic methods for the design and synthesis of prophylactics and therapeutics suitable for the prevention and treatment of viral, bacterial and parasitic disorders.

DESCRIPTION: The prevention and treatment of infectious diseases commonly found in combat environments is complicated: 1) by the general lack of capacity for rational drug design, 2) by the inordinate time lag between characterization of a pathogen and the introduction of putative therapeutics into human clinical trials, and 3) by unacceptable risks of negative side effects. Proposals are sought to develop methodologies/technologies capable of dealing simultaneously with all three issues.

Phase I: Develop proposals which identify novel methodological or technological concepts and focus efforts on central research issue(s) with reasonable scientific progress.

Phase II: Provide initial in-vitro/in-viva proof-of-concept demonstrations, as appropriate, for central issue(s).

DEFENSE NUCLEAR AGENCY

Submission of Proposals

The Defense Nuclear Agency is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology and operations. (Note: we are not interested in nuclear weapon design or manufacture.) DNA invites the small business community to send proposals directly to the following address:

Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed in the Acquisition Management Office and be distributed to the appropriate technical office for evaluation and action. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Nuclear Agency
ATTN: AM, Ms. P. Brooks
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA had identified 20 technical topics, numbered DNA 91-01 through DNA 91-20, to which small businesses may respond in this solicitation (91.1). Please note that these are the only topics for which proposals will be accepted. A list of the topics currently eligible for proposal submissions (followed by full topic descriptions) is included below. The topics were initiated by DNA technical offices. Questions concerning the research topics should be submitted to:

Defense Nuclear Agency
ATTN: PRAS, Mr. J. Gerding
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-1217

DNA selects proposals for funding based upon technical merit, criticality of the research, and evaluation criteria contained in this solicitation document. As funding is limited, DNA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, DNA may fund more than one proposal in a specific topic area of the technical quality of the proposals in question, if deemed superior, or it may fund no proposals in a topic area. Proposals which cover more than one topic need only be submitted once.

DNA INDEX

Defense Nuclear Agency

FY 1991 One Line Topic

DNA 91-01	Nuclear Weapon Effects Calculation
DNA 91-02	Response of Materials to Nuclear Weapon Effects
DNA 91-03	Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Communications
DNA 91-04	Nuclear Weapon Effects Simulation
DNA 91-05	Instrumentation
DNA 91-06	Directed Energy Effects
DNA 91-07	Nuclear Hardening and Survivability
DNA 91-08	Security of Nuclear Weapons
DNA 91-09	Theater Nuclear Forces (TNF) Survivability
DNA 91-10	Operational Planning and Targeting
DNA 91-11	Underground Nuclear Testing
DNA 91-12	Verification Technology Development
DNA 91-13	Nuclear Weapon Effects on Propagation
DNA 91-14	Tactical Application of Pulsed Power Technology
DNA 91-15	Advances in Pulsed Power Technology
DNA 91-16	X-Ray Nuclear Weapon Effects Source Development
DNA 91-17	Response of Insitu Rocks to Nuclear Weapon Effects
DNA 91-18	Draft Tube Rise-Time Enhancement
DNA 91-19	Rise-Time Enhancement for Flash Gamma Ray Simulators
DNA 91-20	Structural Response to Nuclear Weapon Effects

DEFENSE NUCLEAR AGENCY
FY 1991 TOPIC DESCRIPTIONS

DNA 91-01 TITLE: Nuclear Weapon Effects Calculation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the accuracy, runtime and or visualization of output of nuclear weapon effects calculations.

DESCRIPTION: Accurate and efficient calculation of nuclear weapon effects and display/presentation of such calculations are of major concern to DNA. Areas of interest include more accurate calculations, faster running calculations, microcomputer versions to enable use by a wide audience, and new and improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and the survivability/vulnerability of structures and equipment to these effects. Nuclear weapon effects include airblast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; dust cloud formation; and the effects of these on personnel, materials and structures. Structures of interest include deep underground, land-based, sea-based, and aerospace structures.

During Phase I, the research will demonstrate the feasibility of the proposed methodology to calculate and display/present nuclear weapon effects and/or the response of materials and structures to these effects.

During Phase II, the research concepts developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into appropriate codes.

DNA 91-02 TITLE: Response of Materials to Nuclear Weapon Effects

CATEGORY: Exploratory Development

OBJECTIVE: Measure the response of new and existing materials to nuclear weapon effects and develop methods to improve the survivability of these materials.

DESCRIPTION: Of interest to DNA is the response of materials, structures, and systems to nuclear weapons effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as a structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. The response of underground structures such as missile silos, command and control facilities and communications facilities are especially important. Concepts and techniques which will improve the survivability (decrease the response) of these types of systems to nuclear weapons effects are required. New materials with enhanced electromagnetic shielding properties are also of interest.

During Phase I, testing plans and feasibility studies on the material will be completed.

During Phase II, the material will be tested and conclusions from the test results will be drawn.

DNA 91-03 TITLE: Nuclear Weapon and Neutral Particle Beam Effects on Electronics and Comunications

CATEGORY: Exploratory Development

OBJECTIVE: Explore the effects of nuclear weapons and neutral particle beams on electronics and communications.

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation and neutral particle beams on electronics, electronic systems, opto-electrical devices and sensors in the phenomenology areas of:

a) Transient Radiation Effects on Electronics (TREE)
b) Electromagnetic Pulse (EMP)
c) System Generated EMP (SGEMP) are of interest to DNA.

Particular areas of concern include; methods by which designers of space, strategic and tactical systems can assess their susceptibility to TREE, EMP, and SGEMP; hardening technology to reduce the susceptibilities of electronic systems and devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the

response) of systems against these nuclear weapons effects and neutral particle beam are required.

During Phase I, initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

During Phase II, continue the investigate began in Phase I to fully develop the proposed approach.

DNA 91-04 TITLE: Nuclear Weapon Effects Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation.

DESCRIPTION: Simulators are needed to: (1) calibrate gauges; (2) use for developing new gauges; (3) provide experimental data for development of numerical simulations of nuclear weapons effects; (4) simulate one or more nuclear weapons effects at laboratory size scale; (5) predict what will occur during an underground nuclear test; and (6) simulate gravity in small scale water shock and dust lofting tests (centrifuges).

Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to an explosive test site. Small scale simulators are needed to provide extensive data to supplement the limited data from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information. A joint proposal with a government laboratory may be helpful because the simulator can then remain at the government laboratory where it will be readily available for future use.

During Phase I, build the basic simulator and demonstrate that it functions properly.

During Phase II, use the simulator to produce useful data and improve the simulator as necessary.

DNA 91-05 TITLE: Instrumentation

CATEGORY: Exploratory Development

OBJECTIVE: Develop new instrumentation or make improvements to existing instrument used in nuclear weapon effect simulators and in underground nuclear testing.

DESCRIPTION: Instrumentation is used for measuring nuclear weapons effects, phenomenology parameters and the response of test items exposed to real or simulated nuclear weapon effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in underground nuclear tests, high explosive tests, or tests involving high levels of x-ray, gamma, or neutron radiation. The instrumentation should survive long enough to record the needed data. Instrumentation is needed for the following types of tests: airblast, dusty flow, dust lofting, water shock, shock propagation in rock, HE, thermal radiation and underground nuclear tests. Calibration facilities are needed to calibrate existing gauges in every environment where the gauge could be used.

During Phase I, build a prototype instrument and demonstrate that it functions properly using laboratory tests.

During Phase II, demonstrate that the instrumentation can record useful data in its working environment. This will involve coordination with DNA to schedule testing in a simulator or underground nuclear test.

DNA 91-06 TITLE: Directed Energy Effects

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the effects of directed energy and identify materials which may survive effects of directed energy weapons.

DESCRIPTION: The effects of directed energy sources on materials, structures and systems are of interest to DNA. Of particular interest is the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed

energy effects, and mechanisms by which the directed energy sources actually interact with target materials/structures.
During Phase I, demonstrate the feasibility of the proposed investigation.
During Phase II, characterize the effects of directed energy on materials, structures, etc.

DNA 91-07 TITLE: Nuclear Hardening and Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques to improve the nuclear hardening and survivability of defense systems.

DESCRIPTION: Techniques for nuclear hardening and survivability of systems, structures, or personnel against nuclear weapons effects and, where compatible, directed energy effects are required. These techniques should protect the structure or system against the combined effects of blast, thermal, nuclear radiation, and in the cases of structures or materials, and should also provide protection against electromagnetic and radiation effects wherever any electronic capabilities are involved. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulses is required. Systems include planned and operational strategic and tactical ground mobile systems, missiles, aircraft, spacecraft and their subsystems and components.
During Phase I, demonstrate the feasibility and usefulness of the proposed technique.
During Phase II, fully develop the proposed technique and characterize its usefulness in both technical and cost terms.

DNA 91-08 TITLE: Security of Nuclear Weapons

CATEGORY: Exploratory Development

OBJECTIVE: Improve the security of US nuclear weapons against all types of threats.

DESCRIPTION: Measures to improve the security of nuclear weapons against all possible threats are required. These methods are expected to include weapon storage facility designs, transportation facility designs, new security sensors and sensor system development, methods to improve the secure handling of nuclear weapons, and methods to improve the effectiveness and efficiency of nuclear weapon security operations. Proposals should describe how they will improve protection against known and predicted threats and should emphasize weapon concealment where appropriate.
During Phase I, demonstrate the feasibility and potential usefulness of the proposed security measures.
During Phase II, fully develop the proposed security measures so they can be compared to existing techniques.

DNA 91-09 TITLE: Theater Nuclear Forces (TNF) Survivability

CATEGORY: Exploratory Development

OBJECTIVE: Improve the survivability of US nuclear weapons.

DESCRIPTION: The prelaunch survivability (PLS) of the TNF is of vital concern. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats to the TNF include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, theater nuclear force movements, and operational survivability of theater nuclear systems (aircraft, missiles, and cannon systems). Survivability concepts are warranted for the period of the 1990's and beyond. Concepts should employ innovative ideas and make use of new and emerging technologies.
During phase I, demonstrate the feasibility and potential usefulness of the proposed survivability measures.
During Phase II, fully develop the proposed survivability measures so they can be compared to existing techniques.

DNA 91-10 TITLE: Operational Planning and Targeting

CATEGORY: Exploratory Development

OBJECTIVE: Improve the ability of US nuclear commanders to plan for nuclear engagements and target their nuclear weapons.

DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments should be improved. Improvements desired include development of automated planning systems, techniques to determine target damage objective and criteria, post strike target damage assessment capabilities, and automated nuclear weapon employment codes. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

During Phase I, develop the proposed technique in sufficient detail to demonstrate its feasibility.

During Phase II, continue the development of the proposed technique to the point it can be incorporated into existing planning/targeting methodologies.

DNA 91-11 TITLE: Underground Nuclear Testing

CATEGORY: Exploratory Development

OBJECTIVE: Improve the design, execution, and evaluation of underground nuclear tests.

DESCRIPTION: Underground nuclear effects tests are used in situations for which no suitable above ground simulator exists. Areas of interest include improvements in the design and execution of tests (horizontal/vertical line of sight and cavity), the design of new experiments which extend the capability of current test beds, and innovative test concepts to meet future needs. To improve our understanding of the results improvements to the mathematical methods used to perform various calculations within the test design and analysis program are needed. New methods of characterizing existing materials which are used in critical portions of the test bed (such as the A box) and new materials for such applications, new approaches to the geological problems encountered in the construction of the test beds, and new methods for all test activities (excavation, fabrication, assembly in the tunnel complex, recording data, transmission of data) are also of interest to DNA.

During Phase I, demonstrate the feasibility of the proposed test/experiment improvement. This will be done using laboratory and/or above ground testing.

During Phase II, demonstrate the proposed techniques with underground nuclear testing and/or above ground testing.

DNA 91-12 TITLE: Verification Technology Development

CATEGORY: Advanced Development

OBJECTIVE: Improve/develop US technical capability to verify/ monitor compliance with existing and potential future arms control treaties, e.g., START, INF, CW, CFE, NTT, and SNF.

DESCRIPTION: New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations. The problem will basically involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor.

Phase I - Demonstrate the feasibility of the proposed technology.

Phase II - Develop a proof of design to demonstrate the proposed technology.

DNA 91-13 TITLE: Nuclear Weapon Effects on Propagation

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the effects of nuclear weapon explosions on radio signals and the subsequent performance of

communication and radar systems. Investigate the effects of nuclear weapon created optical clutter backgrounds on optical sensor systems.

DESCRIPTION: The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrade the propagation of communication and radar signals and that contain optical clutter backgrounds which degrade optical sensor systems. Part of DNA's mission is to predict effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF communications, HF/VHF communications, radar systems, and optical sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapon energy to the atmosphere; the development of structure in weapon produced plasmas and molecular emitters; the chemical processes which give rise to the optical emissions; the transport and final deposition of nuclear debris; the effects of degraded signal propagation on the performance of communication systems and radars; and the prediction of the effects of optical clutter backgrounds on the performance of optical sensor systems.

During Phase I, demonstrate the feasibility of the proposed investigation to advance the understanding in any of the areas described above.

During Phase II, continue the investigation to the development of a product or results that can be incorporated into the existing technology base.

DNA 91-14 TITLE: Tactical Application of Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Development of new applications of existing pulse power technology.

DESCRIPTION: Recent advances in energy storage and switching now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Concepts proposed should be highly innovative and make full use of the emerging pulse power technology.

During Phase I, demonstrate the feasibility of the proposed pulsed power application.

During Phase II, continue the development of the concept to an engineering model and conduct tests of the effectiveness of the idea.

DNA 91-15 TITLE: Advances in Pulsed Power Technology

CATEGORY: Exploratory Development

OBJECTIVE: Dramatic Improvements in energy storage, switching, and power conditioning state of technology

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, and performance. Innovative approaches for component or subsystem development are sought to meet the needs of radiation simulators and tactical applications requiring operation at kilovolts to megavolts, kiloamperes to megaamperes, and repetition rates from single pulse to 10 kilohertz.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle hardware.

DNA 91-16 TITLE: X-Ray Nuclear Weapons Effects Source Development

CATEGORY: Exploratory Development

OBJECTIVE: Innovative concepts for the production of x-ray radiation used in nuclear weapon effects testing.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 kev), warm x-rays (5-15 kev), and hot x-rays (>15 kev). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing.

The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.
During Phase I, demonstrate the feasibility of the proposed concept.
During Phase II, develop, test, and evaluate proof-of-principle x-ray source capability.

DNA 91-17 TITLE: Response of Insitu Rocks to Nuclear Weapons Effects

CATEGORY: Exploratory Development

OBJECTIVE: Development of methods to measure material properties of insitu rock and the incorporation of this data in ground shock/ground motion models.

DESCRIPTION: Techniques are required to measure the stress history that corresponds to a spherically diverging stress wave in medium-strength rock. The transducer must survive long enough to measure the stress history through the positive phase for peak radial stresses between 0.2 and 2.0 kbar (20 and 200 MPa).

During Phase I, conduct feasibility analyses to demonstrate viability of the proposed with special emphasis on sedimentary rocks.

During Phase II, implement the proposed techniques small scale field explosive experiments.

DNA 91-18 TITLE: Drift Tube Rise-Time Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: Improved calculational capability to predict rise-time sharpening effects using drift tubes in x-ray simulators.

DESCRIPTION: The use of drift tubes containing low pressure gas to sharpen the rise-time of electron beams in x-ray simulators for improved fidelity is of interest to DNA. Empirical evidence exists to substantiate the concept; however, accurate calculational capability is required to exploit and guide the experimental program. Important variables include gas constituents and pressures in the 1 mtorr to 1 atm range. Both collisional and non-collisional regimes are of interest for the secondary electrons. Methods to accurately predict the time dependance and phase space of the primary electron beam on target are required.

During Phase I, demonstrate the feasibility of the proposed methodology through calculations against experimental data.

During Phase II, fully develop the proposed methodology and implement it in appropriate codes.

DNA 91-19 TITLE: Rise-Time Enhancement for Flash Gamma Ray Simulators

CATEGORY: Exploratory Development

OBJECTIVE: Identify and develop new techniques for substantial reduction of radiation pulse rise-time on flash x-ray simulators.

DESCRIPTION: High fidelity simulation of tactical source region electromagnetic pulse (SREMP) is required to test the vulnerability of critical military systems. To achieve higher performance and versatility than presently available a substantial reduction of the electron rise-time at the converter is required. DNA is seeking innovative approaches which offer significant improvement over existing techniques without reducing dose rate. Hardware reliability and survivability in the harsh sirmostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle x-ray source capability.

DNA 91-20 TITLE: Structural Response to Nuclear Weapon Effects

CATEGORY: Exploratory Development

OBJECTIVE: Improve the design and hardness assessment of structures to nuclear weapons effects.

DESCRIPTION: Improved designs of hardened structures are needed as well as a better understanding of failure mechanisms of structures. Type of structures include deep underground, land-based (fixed and mobile), sea-based (floating and submerged) and aerospace structures. Designs are needed to resist conventional as well as nuclear weapons effects. Improved methods are needed for analysis and model testing of structures to large deflection and collapse damage levels. Models are required for energy deposition and thermomechanical response of heterogeneous and anisotropic composite materials subjected to X-ray exposure. The models for material behavior must be compatible with conventional structural dynamics computer codes.

During Phase I, the research will demonstrate the feasibility of the proposed designs/methodology to determine structural response to nuclear weapon effects.

During Phase II, the research concept developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into other existing methodology/codes.

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Send Phase I proposals (one RED original and four copies of the full proposal, PLUS three copies of Appendices A and B only) by US mail to:

Strategic Defense Initiative Organization
ATTN: TNI/SBIR
Washington, D.C. 20301-7100

For Administrative Help Only: Call 800-937-3150

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. **WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient.** Receipt of proposals will be acknowledged only if the proposal includes a self addressed stamped envelope and a form (like Reference B) that needs only a signature by SDIO.

SDI is a DoD project to explore the feasibility of finding and disabling a ballistic missile in flight.

Topics on the following pages broadly state SDI's interests. SDI seeks innovative concepts on the cutting edge of technology that might enable a defense against a missile in flight. SDI seeks concepts for its need of lighter, faster, smarter, more reliable components. The proposer need not know details of possible SDI syste...s. SDI will also consider highly innovative technology that does not clearly fit into any specific topic.

SDI SBIR seeks a demonstrable product that makes a leap in capability. SDI seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably commercial) and a measurable SDI benefit. SDI SBIR will not fund ordinary research or studies (including surveys, assessments, data collection, or systems studies). Nor will it further develop concepts already mature enough to compete for venture capital or government development funds.

Phase I will show the concept feasibility and the merit of a Phase II that will demonstrate a prototype or at least show proof-of-principle. The development must be appropriate for a small firm. Principal Investigators who are tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract. Any waiver must be requested explicitly with a justification showing a compelling national need. SDI expects to grant no waivers.

SDIO INDEX

WORD/PHRASE	TOPIC No.

STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH
TOPICS

SDIO 91-001	Directed Energy Concepts
SDIO 91-002	Kinetic Energy Weapons
SDIO 91-003	Sensors
SDIO 91-004	Nuclear Space Power
SDIO 91-005	Non-Nuclear Space Power and Power Conditioning
SDIO 91-006	Propulsion and Logistics
SDIO 91-007	Thermal Management
SDIO 91-008	Survivability
SDIO 91-009	Lethality
SDIO 91-010	Computer Architecture, Algorithms, and Language
SDIO 91-011	Optical Computing and Optical Signal Processing
SDIO 91-012	Space Structures
SDIO 91-013	Structural Materials
SDIO 91-014	Electronic Materials
SDIO 91-015	Superconductive Materials

STRATEGIC DEFENSE INITIATIVE ORANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM

SDIO 91-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy plays an important role in developing an effective ballistic missile defense system. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, and free electron lasers. Hybrid approaches are also of interest. Interests in the concepts include the full range of embodiments, i.e., low mass spaced-based, ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, optics, and countermeasures.

SDIO 91-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons are candidates for strategic defense systems. System candidates presently include ground-based exoatmospheric re-entry vehicle interceptors (ERIS) and space-based interceptors (SBI), high endoatmospheric defense interceptors (HEDI) and hypervelocity guns (HVG) [electromagnetic (EM), electrothermal (ET), and hybrid systems]. Approaches are sought which extend, facilitate, or reduce the cost of the concepts. Elements of the systems include the space-based carrier vehicles (CV) or ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: SBIR acquisition of booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C. G. Control algorithms, fast frame and U.V. Seekers, acquisition and track; ERIS target discrimination, seeker operational environments, lethality/miss distance; HEDI aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control and projectile launch survivability; and, common among all systems reliability; producibility, maintainability, and low cost/low mass.

SDIO 91-003 TITLE: Sensors

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), superconducting focal place detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based SDI application (uv-sub-mm wave), new optics and optical materials. Entirely new approaches as well as approaches that expand and improve present concepts are sought.

SDIO 91-004 TITLE: Nuclear Space Power

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include thermionic and Rankine cycles. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of Topic 91-007, innovative thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO 91-005 TITLE: Non-Nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of Topic SDIO 91-04, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO 91-006 TITLE: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operation of the spacecraft have been major factors in the determining the life cycle costs of space-based assets. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluent, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of the SP-100 reference mission and solar power demonstration missions incorporating arcjet thrusters, SDI seeks 30 kw arcjet thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid) in 30-1000 g range.

SDIO 91-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations must dissipate heat. Expected power levels required for SDI space platforms will stress state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems and space platform payloads. Some space platforms will require years of storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, nuclear and non-nuclear, and can satisfy these projected space platform requirements.

SDIO 91-008 TITLE: Survivability

DESCRIPTION: The Strategic Defense System elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is

needed for threat sensing, creation of false aim points and passive hardening. Contribution s are sought in analytic methods, computer simulation/modeling, materials development and processing, component hardware, systems, design and analysis.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors which can characterize the threat according to direction of attack, and spectral characteristics are particularly noteworthy. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. SDS elements have common mission critical subsystems. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, R and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and rejection of R energy are of particular interest. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and R radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality are essential.

SDIO 91-009 TITLE: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. Innovative ideas or concepts for measurement of radiation of particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off. New concepts to produce higher probability of kill-given-a-hit.

SDIO 91-010 TITLE: Computer Architecture, Algorithms, and Language

DESCRIPTION: Strategic defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.
- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.
- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.
- Language design to develop code optimized for highly parallel processed architectures.
- Testing techniques that will provide a high level of confidence in the successful operation of extremely large software systems.
- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).
- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.
- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

SDIO 91-011 TITLE: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

SDIO 91-012 TITLE: Space Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vessels. All of these present individual challenges in terms of stiffness, impact resistance, high temperature capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Techniques for both passive and active control of the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression. There is also a need for novel, lightweight large optical structures that are compatible with the space environment, and for innovative optics/information processing techniques which maximize the imaging performance that can be achieved with imperfect, temporarily unstable structures.

SDIO 91-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 91-012 will depend on major improvements in material properties and cost effectiveness. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Specific goals requiring advances techniques and processes include imparting oxidation resistance and damage tolerance to composites, enhancing the static and dynamic toughness of ceramic composites, and creating fatigue-resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to minimize fiber-matrix reactions in composites exposed to high operating temperatures. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, low density alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. The following are sought: innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e., aluminum or magnesium), or thermoplastic matrix composites; innovative procedures for the production of consistent starting materials for advanced composites; novel instrumentation, sensors and software for on-line process monitoring and devaluation of high modulus, fiber-reinforced composites; novel approaches to modify surfaces to promote fiber/matrix adhesion in advanced composites; innovative surface modifications to promote wear resistance; innovative tooling techniques for neat-net shape production of advanced composites; novel, low-to-no outgassing joining/bonding techniques for advanced composites; novel instrumentation for telemetry of material properties and data from space; novel approaches for analytical modeling of generic space structures with experimental verification; new types of embedded active/passive sensors for structural control and real-time monitoring of structural behavior; and new methods for integrating instrumentation (i.e., embedded sensors) into advanced composite materials and structures. Proposals involving these as well as other space structure and material-related research and innovative technology topics are sought.

SDIO 91-014 TITLE: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronics materials.. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many SDI electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

SDIO 91-015 TITLE: Superconductive Materials

DESCRIPTION: Interest in these high temperature superconducting materials includes characterization, stabilization of new high-Tc phases, and development of novel fabrication techniques for both the thin-film and bulk materials. Areas of application are also being stressed and include: novel, low-power infrared (IR) staring-array sensors, particularly those with monolithic focal plane pixel arrays and read-out electronics; high-Tc superconductive materials for various electronic applications, e.g., Josephson junctions and SIS mixers; bulk materials for power transmission, conditioning, and storage; compact, high gradient accelerator cavities for novel particle beam and free-electron laser design concepts; magnetic shielding of critical components from EMP effects. Note that in the applications area interest is not limited to only this new class of high-Tc superconductors but attention is also given to the more mature low-Tc materials as well, e.g., Niobium and Niobium Nitride.

Reference A

PRIOR YEARS RESULTS OF DOD SBIR PROGRAM

FY 83 - FY 89	Number of Topics	Proposals Received	Phase I Awards	Phase II Awards
ARMY	1279	10151	1185	451
NAVY	1332	10141	1358	427
AIR FORCE	1540	12887	1890	581
DARPA	182	2088	302	53
DNA	62	1034	142	26
*SDIO	74	3229	695	171
	4.469	39,530	5,572	1,709

FY 90.1	Number of Topics	Proposals Received	Number Selected for Phase I Negotiations
ARMY	206	2445	213
NAVY	310	2626	266
AIR FORCE	199	2512	231
DARPA	61	564	95
DNA	17	225	17
SDIO	15	710	100
	808	9,082	922**

* SDIO began participation in FY 1985
** Awards made as of July, 1990.

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